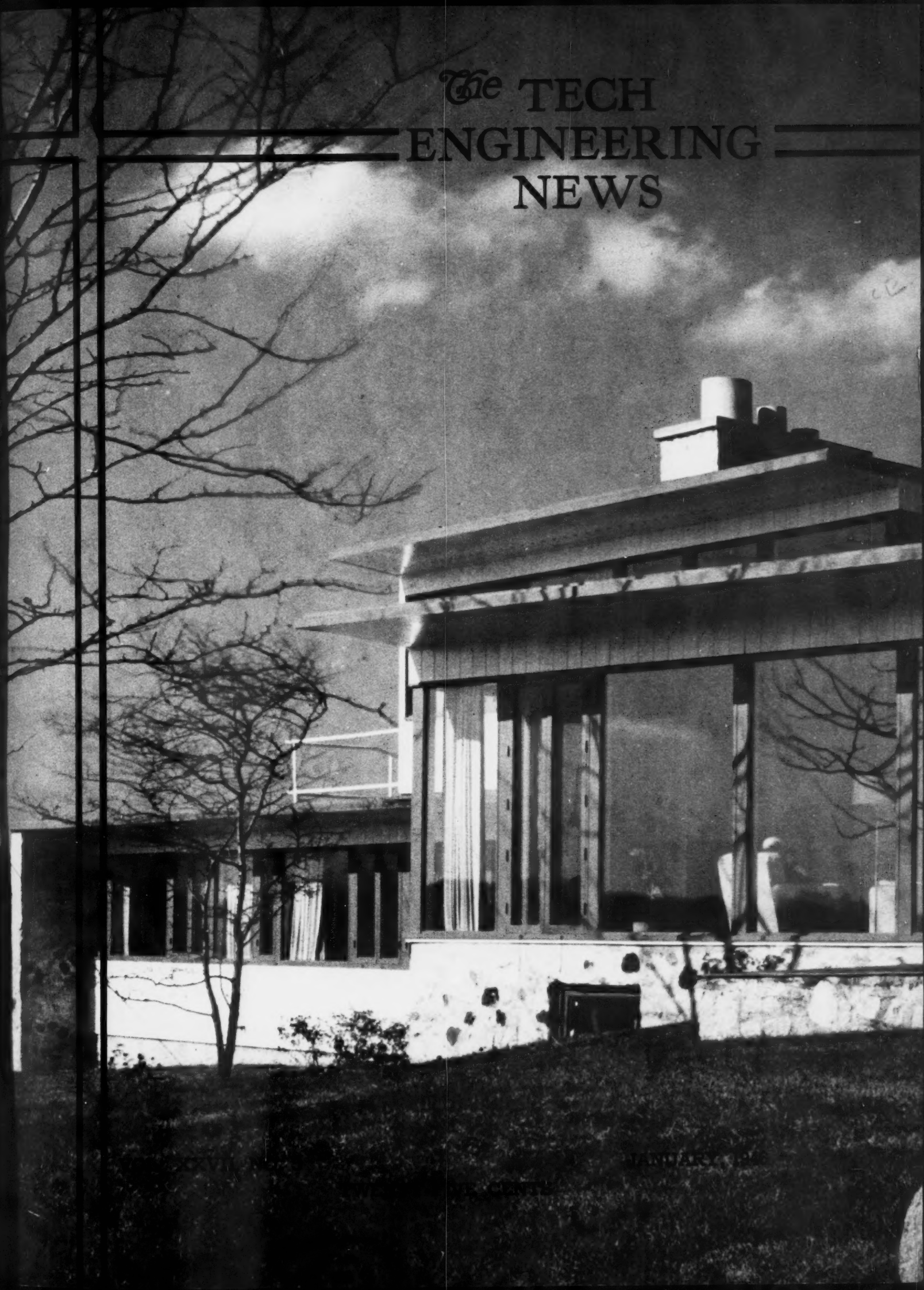
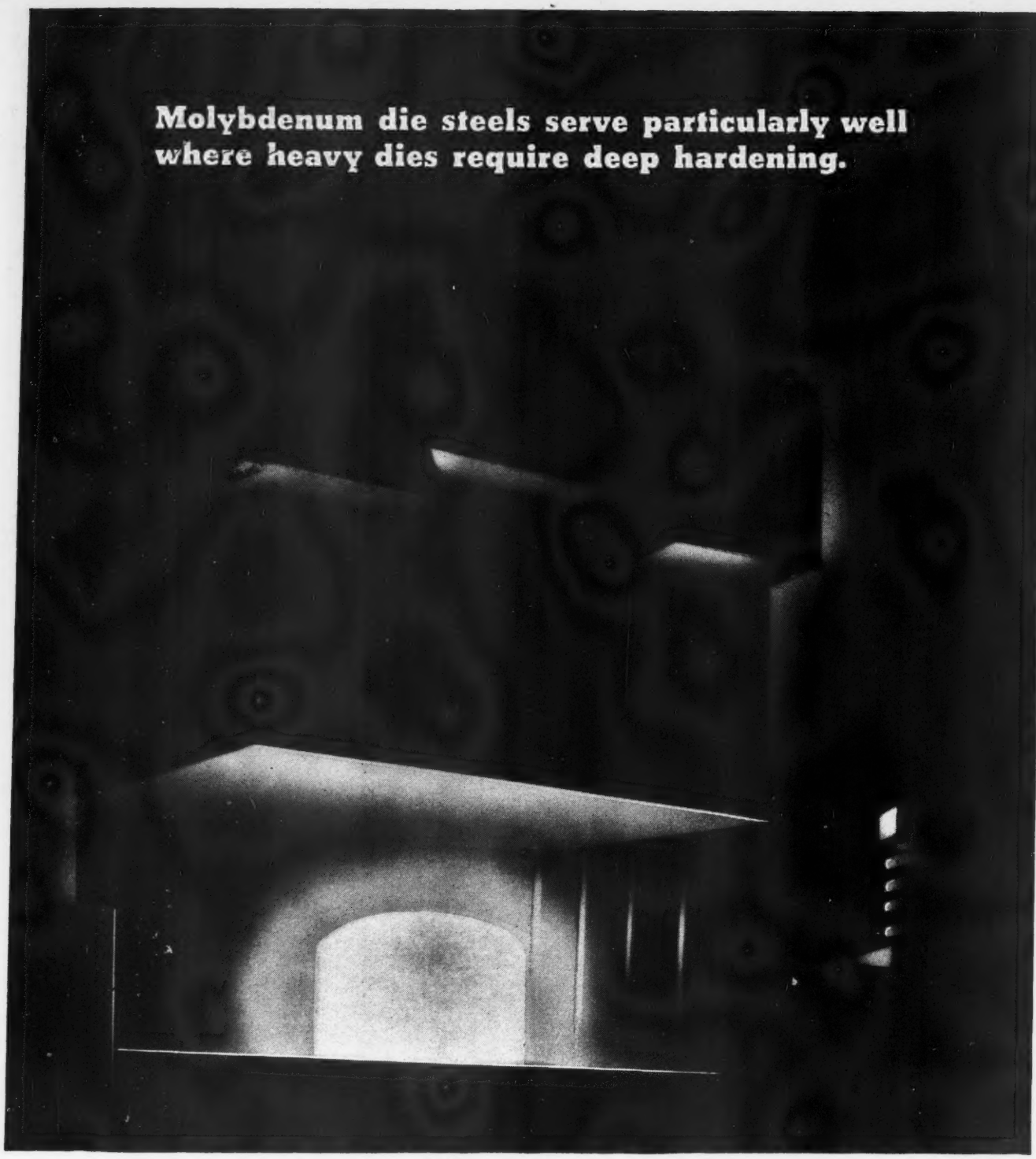
The TECH ENGINEERING NEWS



Molybdenum die steels serve particularly well where heavy dies require deep hardening.



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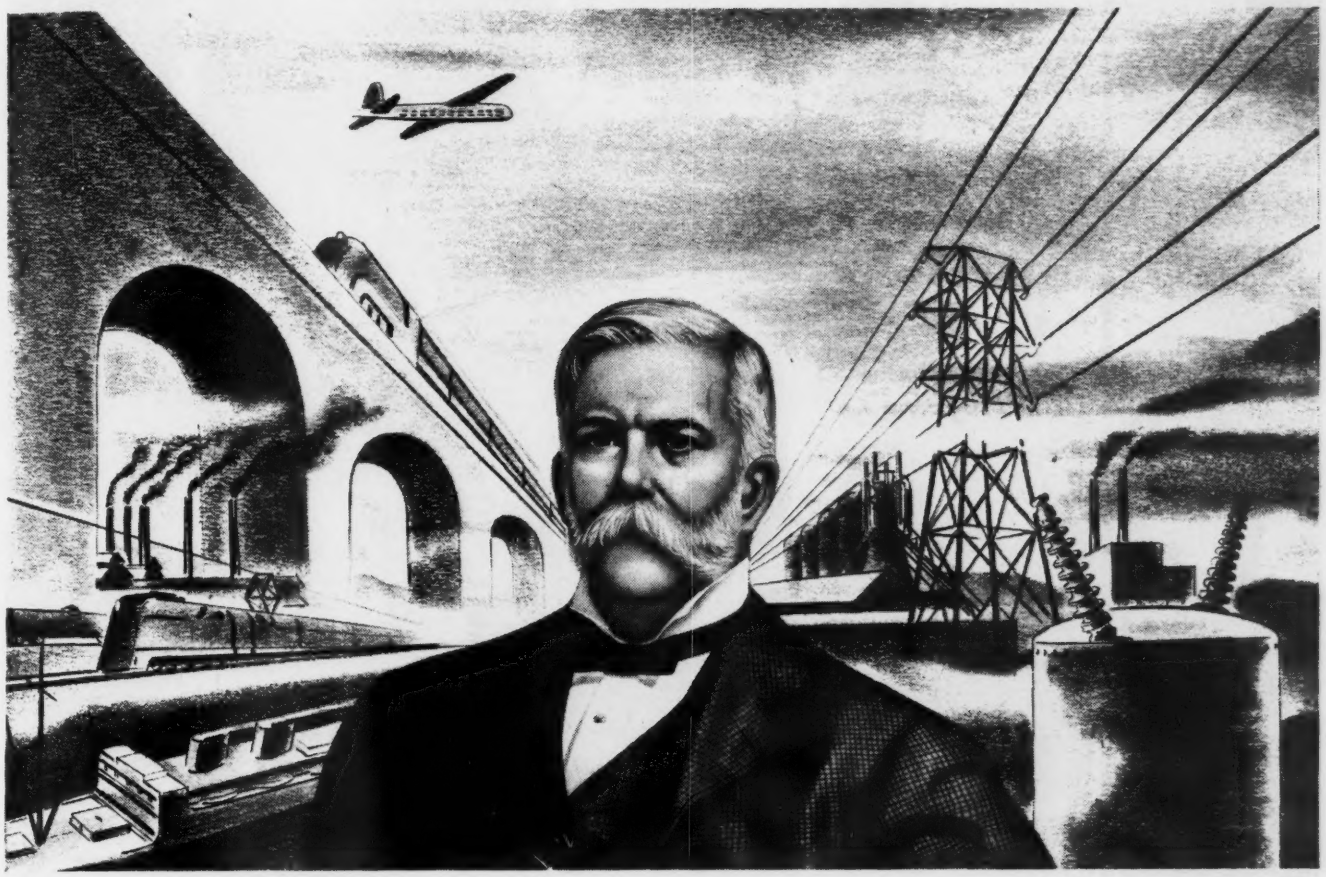
GEORGE WESTINGHOUSE CENTENNIAL — 1846-1946



He was the "greatest living engineer"

This year we celebrate the 100th Anniversary of the birth of a man the world will long remember—known internationally in his time as the "*greatest living engineer.*"

Early in life George Westinghouse showed marked inventive genius. When only 22 years old, he conceived the idea of the railway air brake . . . the first of many epoch-making inventions that made him world famous.

But George Westinghouse was not only a distinguished inventor—he also had the engineering "know how" to develop his ideas into *practical, workable form.*

For example, he pioneered in the development of the first practical alternating current system for long-distance transmission of electric power . . . the steam turbine for use on land and sea . . . the induction motor . . . railway electrification and automatic block signaling.

As an industrial leader, he founded many companies that were to bring untold benefits to people all over the world. The largest of these is the Westinghouse Electric Corporation.

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Wherever electric power is produced and distributed . . . or electricity is used in industry and the home . . . or world's trade moves . . . you will find equipment and practices stemming from the genius of George Westinghouse.

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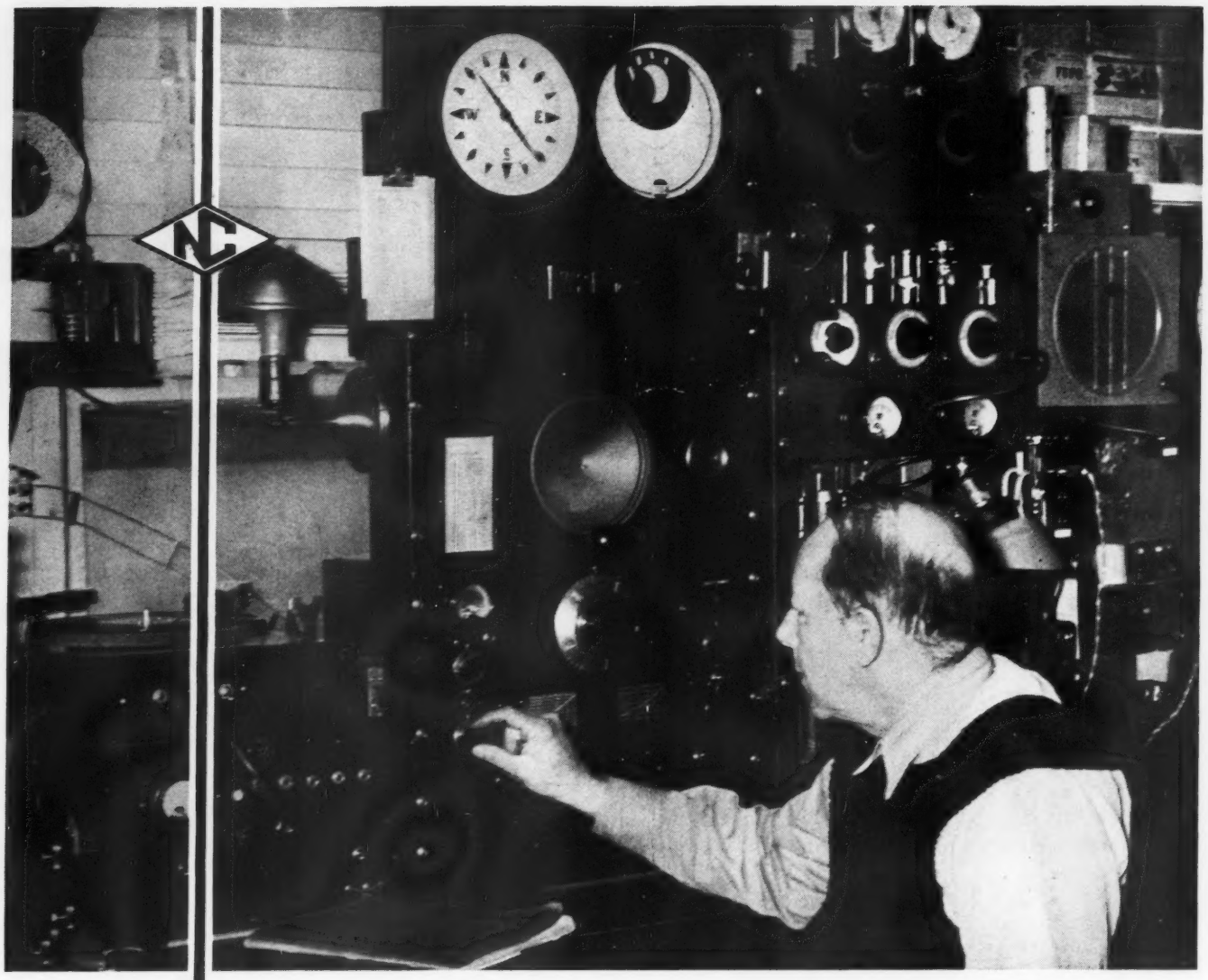

CAPTAIN HORACE L. HALL, U.S. Merchant Marine, retired, at his home in Springfield, L.I., N.Y., made daily recordings of transmissions from Australia, for more than four years, missing but four days. The apparently harmless news broadcasts kept the Australian Government in New York and Washington informed of every phase of the progress of the war, by a prearranged code.

The National HRO, used for this remarkable accomplishment is the first ever to have been shipped into the New York area and is over ten years old.

NATIONAL COMPANY INC., MALDEN, MASS.

The TECH ENGINEERING NEWS

PROFESSIONAL JOURNAL OF THE UNDERGRADUATES

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Volume XXVII, No. 5

JANUARY, 1946

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MEMBER OF THE
ENGINEERING COLLEGE MAGAZINES ASSOCIATED

Published monthly during the school year at Walker Memorial, Cambridge 39, Massachusetts, by the undergraduates of the Massachusetts Institute of Technology. Entered as second class matter, at the Post Office, June 1, 1920, at Boston, Mass. under the Act of March 3, 1879.

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Subscription per year $1.50. Foreign $1.75. One copy 25 cents.

Hedrick-Blessing Studio

A Place in the Sun

By ALVIN J. SITEMAN, 2-48

SCIENTISTS have long striven to harness the vast amount of energy which the earth receives from the sun. The Smithsonian Institute, the Massachusetts Institute of Technology, and the Illinois Institute of Technology have been sites of extensive research, and experimenters' results have varied from Dr. C. G. Abbot's solar furnace to Dr. Bruno Lange's "sunshine sandwiches."

It has long been known that black and rough surfaces are the best heat absorbers. Transparent substances, such as glass, will allow light and heat waves of high frequency to pass through, but such substances are more opaque to heat rays of lower frequency. Professor Langley employed these principles in his researches on solar energy. Langley experimented with the purpose of determining the amount of heat received from the sun that is absorbed in our atmosphere. He constructed two stations on Mount Whitney in California and measured the heat absorbed by the atmosphere between them. A thermometer was placed in the innermost of a nest of shallow boxes which were painted black, separated by air spaces, and covered with ordinary window glass. This thermometer rose as high as 113° C. when exposed to the sun's rays, while the outside temperature in the shade was 14.8° C. This experiment helped to show the tremendous amount of heat that could be held by a rather simple apparatus.

E. S. Morse of M. I. T. did some of the important preliminary work about 1885. He said that his attention was first called to the possibilities of solar heating when he observed dark curtains hanging before windows into which the sun's rays were shining. These curtains became very warm and this caused an upward current of heated air. The principle observed here was utilized to build a heater for a museum in Salem, Massachusetts. The hall was 100 feet long, 40 feet wide, and 21 feet high. The heater used was made of a box 13 feet high and 4 feet wide, open at the bottom, and communicating at the top with the ceiling of the hall. The outer face was constructed of black corrugated iron, in front of which was a glass plate with several inches of clearance between the box and the plate. The outside air passed in behind the warm iron and upon being heated ascended and passed into the room at the top. The plate was placed behind sashes inclined at 30° to the horizontal, the purpose being to intercept as many of the sun's rays as possible. This particular apparatus did not have any appreciable effect on the temperature of the hall, but the air was conditioned and entirely changed every two days. The air passing through the heater increased about 30° F. in temperature, but the temperature of the room was not affected due to the small quantity of heated air.

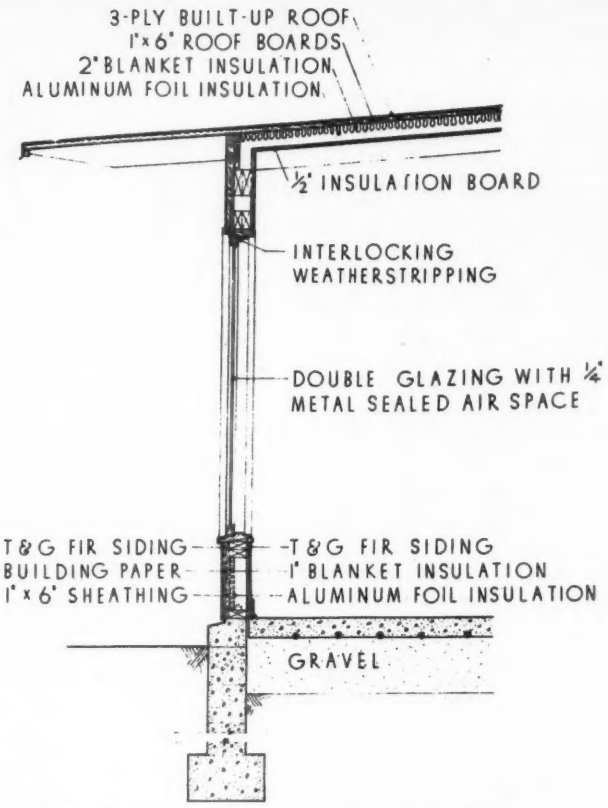
Morse built a solar heater for his home which was slightly different from the one used in the Salem museum. Slate replaced the corrugated iron, and a glass plate was placed vertically outside of it with three-fourths of an inch clearance. Between the slate and the wall of the house was a flue through which the heated air ascended. The flue was three feet wide and four inches deep. At the foot of the flue there was a damper which could be opened or closed from within the house. When the damper was open, outside air could enter and pass up the flue and into the room at the ceiling. If the bottom damper was closed, no outside air could enter; but air from the lower part of the room could pass out into the flue and ascend, entering the room again at the ceiling. In the summer the sun is high and the slate was not heated very much because most of the rays were reflected. The room that was heated by Morse's equipment was nine feet high and contained twenty-five hundred cubic feet of air. The air in the room was changed every forty-five minutes, but this solar heater was used only as an auxiliary. The main advantages of Morse's device were that the room was free from dust and cinders and that the fire hazard was minimized. Other experimenters worked on solar heating after Morse did, but not much advance was made until the late 1930's when Dr. Charles Abbot, director of the Smithsonian Institute, constructed a series of solar engines which attracted attention. His machines were heat-gathering aluminum mirrors used to boil water, and the steam produced could then be used for heating or to run small engines. California workers went even farther and built a solar power station to generate electricity. Similar experiments were carried out in Spain and Egypt. Dr. Bruno Lange of Berlin built "sunshine sandwiches," which were simply photoelectric cells used to generate electricity when struck by the sun's rays. Others employed parabolic mirrors and large lenses to concentrate heat and melt metals.

General view of the dining room
Hedrich-Blessing Studio

The facts showed that it was definitely worth while to attempt to capture the sun's energy. For example, it is estimated that enough rays fall annually on New Mexico to furnish one hundred times the energy that the United States uses each year from coal, oil, and water power combined. Also, enough solar energy is received each year on almost any building, even a factory, not only to heat it but to operate all machinery that it may contain. Power from the sun amounts to three-eighths horsepower per square yard on the average. On a house 30 by 36 feet in floor dimensions, about 45 horsepower is received. This energy for 24 hours is about equal to the total energy in 160 pounds of good coal. Since no house of this size uses more than 160 pounds of coal per day, solar energy is sufficient for house-heating in mid-latitudes, providing that it may be efficiently stored and used.

The Massachusetts Institute of Technology took up the problem in an attempt to find the best way to store the sun's vast energy. Theoretically, this energy may be stored as heat, chemical, electrical or mechanical energy. M. I. T. scientists chose water as the storer of the solar energy. There were several reasons for this particular choice. First, water is cheap, easy to handle, and safe. Second, more heat is required to raise the temperature of a pound of water a given amount than to raise the temperature of a pound of any other solid or liquid the same amount; consequently the water will give up more heat per pound when cooling than any other solid or liquid.

M. I. T. constructed a white frame building with a slanting roof covered with a battery of solar heat traps. These cells were formed of sandwiches of glass sheets, air spaces, and metal plates. The rays of the sun penetrated through the sheets of glass, and then struck the black metal plate at the bottom of the cell. The cell absorbed heat rapidly and the air spaces between the glass plates acted as insulators to keep the heat from passing out. Water contacted the bottom of the metal plates and was heated by conduction. Metal tubes carried the heated water to an efficiently insulated storage tank in the basement of the building. Thick layers of mineral wool were used as insulators. The hot water could be stored in these tanks for weeks. Experiments on concentrating heat with paraboloidal mirrors were also carried out, all with the aid of $650,000 donated by Dr. Godfrey Cabot of Boston



TYPICAL WALL SECTION

The Architectural Forum

By 1940, the architectural world was very much interested in the possibilities of solar houses. George Keck, a Chicago architect, built a number of them around Chicago. He constructed a "House of Tomorrow" at the Century of Progress Exhibit, and its wall space was ninety per cent glass. He was amazed when he found that this "glass house" was heated by the sun's rays on a bitter cold day, when the furnaces had been off most of the day. Greenhouse owners reported how they would shut off their furnaces from dawn to dusk in the winter because the sun did the necessary heating. H. M. Sloan, a Chicago real estate man, built ten solar houses and he reported that his own fuel bill was substantially lower than that estimated by engineers.

The whole house as seen from the driveway. Dining room and porch are on the other side

Hedrich-Blessing Studio

In these solar houses all of the main rooms face south behind a wall of clear glass. A wide eave shuts out the direct rays of the high summer sun and keeps the inside cool. When the winter sun is low, it shines under the eave and heats and lights the room.

In 1941 the Illinois Institute of Technology started their one-year observation of one of Keck's solar houses. The data was taken at the home of Mr. and Mrs. John Bennett from October, 1941, to October, 1942.

The glass used in the house is double glazed, metal-sealed compound glass which has a one-fourth inch dry-air space between the two panes. The stone used on the inside and outside walls is glacial deposit

taken from the site. The roof is flat so that it can hold a sheet of water which would offer natural protection from the summer sun. Small holes in the overhanging ledges are used for ventilating the space above the ceiling insulation. The floor of the house is a concrete slab, and embedded in the underside of the slab are coils of three-fourths-inch wrought-iron hot water pipes. The hot water is generated in an automatic gas-fired boiler and is circulated by a one-sixth-horsepower electric pump. The injection of hot water into the pipes is controlled by an inside-outside temperature control system.

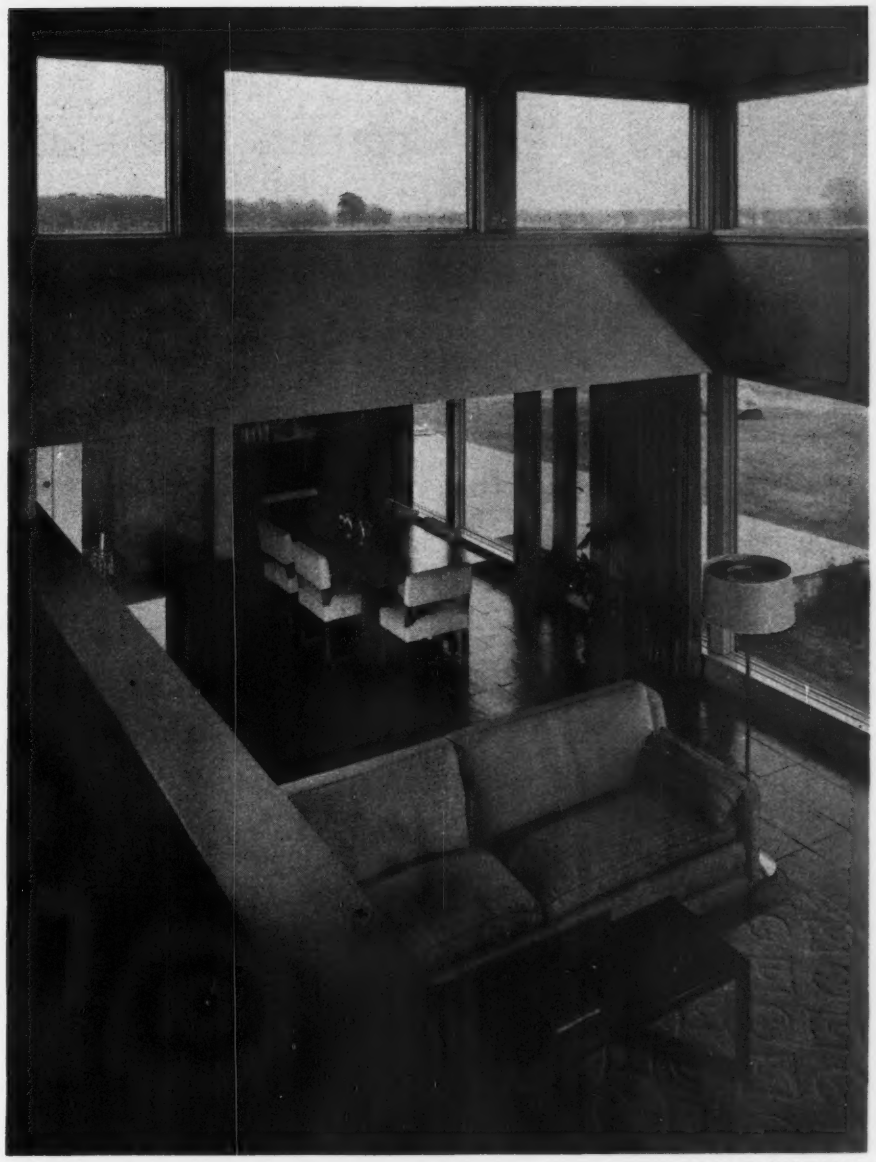
The temperature throughout the house and outside the house was recorded daily. Also, wind velocity and direction were noted. Periodic comparative temperatures of energy radiated from the sun were made inside and outside the house with sensitive thermopiles and galvanometers. Weather conditions and indoor illumination intensities were recorded. The temperature of the water passing through the heating coils was observed, together with the rate of hot water injection to the heating system and the time of operation of the centrifugal water pump. The quantity of gas consumed for heating was metered.

All of the information obtained was used to calculate heat losses and gains. The figures on heat losses and gains are unreliable since there are many incalculable variables in heat loss. However, the heat gain from the floor radiant system was easy to measure. Heat losses in the test house are caused by many things. For one, heat is lost through cracks, doors, and windows. Because of the exposed position of the house, wind velocity is above normal; therefore, it was necessary to use 15 m.p.h. as a conservative average. Heat losses through the floor were very difficult to determine. The rated coefficient for concrete floor slabs on the ground varies in the *Heating, Ventilating, and Air Conditioning Guide.* The figure used was 0.10 Btu/sq. ft./hour/degree F. The *Guide* also gives different values for the temperature difference between the floor and the subsoil. In the Keck test house, the temperature of the underside of the slab was 110° F., while that of the top surface was 88° F. and the air temperature of the room was about 72° F. Usual calculations on heat losses are based on a temperature difference of 82° F. between the inside and the outside of the floor. Presence of frost in the ground threw off the calculations. All data were then classified as either acceptable or debatable. Cracks about the floor and windows were allowed for by computing their length times the standard coefficient of unweatherstripped windows.

The total seasonal heat loss was estimated to be 1,850 therms (1 therm = 100,000 Btu), while the actual fuel consumption showed a heat input of only 1,720 therms. This indicates that the solar heat gain amounted to at least 130 therms. However, with a small change in some of the debatable calculations, the solar heat gain would be much different. One such change would show 1,290 therms gained, while another will show only 40 therms gained by solar energy. These figures may be compared with the theoretical calculations of solar heat input based on weather information. According to a study by Henry Feigin ("Effect of Isolation on the Design of Window Areas," graduate thesis in Architecture, Columbia University, N. Y., 1938), the average solar heat gain through windows facing south is 1.7 therms per square foot in the New York and Chicago areas. Calculated seasonal loss through thermopane during the test season equals 0.6 therm per square foot. If it is assumed that these two calculations are similar, then the net solar input is 1.1 therms per square foot on the south windows of the Keck house. The heat gain for the Keck house would then amount to about 330 therms rather than 130 therms.

Operation of the floor heating system was fair. The temperature of the ceiling was always less than the floor, but the difference was much less than usual in the convection-heated houses. Low ceiling temperatures

(*Continued on page 176*)



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The dining room as seen from second floor, showing window arrangement and a portion of the living room

Precision Casting

By DONALD A. HURTER, 6-46

IN recent years the "lost wax" method of precision casting has been widely used in a growing number of processes. Formerly, the only users of this type of casting were manufacturers of surgical and dental instruments and some jewelers. As the equipment used by these instrument-makers and jewelers was small and not easily adapted to large-scale production, several companies began to design new and better equipment. More efficient centrifugal casting machines of greatly increased capacity were designed, as was special induction heating apparatus. These new machines were first put into use in the manufacture of supercharger exhaust buckets and proved themselves very satisfactory. Since then precision casting has taken over many jobs and has done them more cheaply and more efficiently than they could have been done before.

The actual process of casting is usually divided into four steps. First a master pattern is made, next a wax pattern, then the final mold, and last, the metal is cast.

The making of the master pattern requires the greatest accuracy of the whole process. This pattern is usually made of hardened tool steel and must have dimensions allowing for the combined shrinkage and expansion encountered in the entire process. There is shrinkage of the metal mold, of the wax pattern, of the cast metal piece, and expansion of the final investment mold during the pre-heating of this mold. All these factors must be considered when the master pattern is made. This will be discussed later.

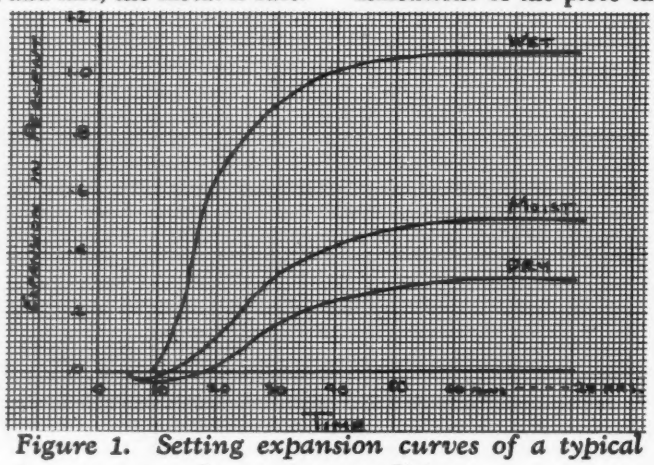


Figure 1. Setting expansion curves of a typical investment under various conditions

After the master pattern has been constructed, a soft-alloy mold is prepared from the pattern. This is usually done by pressing the hard steel pattern into a soft-alloy die blank to form the cavity of the mold. Soft-alloy molds are easy to make; but after a number of wax patterns are made from them, they lose their accuracy and become worthless. To offset this disadvantage, steel molds are sometimes made. These molds have been known to make as many as sixty thousand wax castings without distortion. If steel molds are used, no master pattern is necessary because the cavity of the mold is made to the correct dimensions, but the difficulty of making such molds often causes a bottleneck in production. Therefore soft-alloy or brass molds are used when the number of castings to be made is small.

When the primary metal mold has been made, liquid wax is injected into it under pressure to form a wax pattern. It is necessary that this wax have special properties. It must be non-corrosive so that it does not injure the metal mold and distort the dimension; it must be strong enough to withstand ordinary handling at room temperature; it must not crack or chip; it must undergo little shrinkage upon solidification; and (as will be seen later) it must be able to be evaporated from the final investment mold without leaving any carbon residue to contaminate the metal casting.

The wax pattern is covered with a coating of investment in the next step of the process. To accomplish this, the pattern is placed in a metal cylinder so that it does not touch the sides while the investment is poured around it. As the investment is poured, the entire system is vibrated in a partial vacuum to remove any air bubbles that might be present in the investment. Requisites of this investment are that it must be easily removable from the finished casting, that it must not corrode the casting, that it must produce no distortion on the wax pattern when it dries, and it must be fairly fast to produce a smooth, accurate casting. After the investment has hardened, it is heated in a steam bath to vaporize and remove the wax pattern. When all the wax has been removed, a cavity is left having the dimensions of the piece that is to be cast.

Now the investment mold is heated to between 900° F. and 1050° F., well into the red color range. The heating of the mold assures its complete filling. The metal is then poured into the mold and allowed to cool. When it has cooled sufficiently, the investment is blasted off either by water or steam. The casting process may be divided into three parts: (1) forcing of the metal into the mold under pressure; (2) the conventional centrifugal casting process; and (3) centrifugal casting for multiple molds. After the casting has been cleaned of the investment, some machining or sanding may be necessary; but usually the piece may be used as it comes from the mold with only a slight finishing grind.

The practical method having been described, it is now advisable to enter into a discussion of the physical principle that serves as the basis of all processes for producing accurate casting in investment. Figure 1 is a curve showing the expansion of a typical investment under various atmospheric conditions. These conditions are achieved by lining the metal cylinder with layers of moist asbestos. The investment is made of some refractory material; it usually consists of plaster of Paris and silica. The next two curves show that the silica expands when heated, which is to be expected, but that plaster of Paris is peculiar in that it shrinks tremendously upon heating. By the correct combination of these two materials, the most desirable investment materials are received. Next is a curve showing the thermal expansion and shrinkage of a typical investment material. (Figure 4.) With a given design and specifications, shrinkages and expansions are calculated from known data and curves. The casting shrinkage which is caused by: (1) contraction of liquid from casting temperature

(*Continued on page 174*)

Precipitron—Scavenger of the Air

By MARTIN KAPLAN, 2-48

FOR years, the nature and usefulness of electricity have been known, but not until the creation of electronic devices was its versatility fully realized. Today, in American homes modern labor-saving electronic implements are being installed. Our communication and transportation systems rely heavily upon electronics. The pulsation of the country's industries is articulated by electronic machinery.

The use of electronic contrivances is rapidly becoming more prevalent throughout industry. Many new applications in production, maintenance, and protection operation are coming into view. Among the specialized fields in which the electron tube plays a large part is that of precipitation, that is, removing dust, oil vapors, and similar discomforting and dangerous contaminations from the atmosphere.

The electronic device which regulates this work of precipitation is a high vacuum, hot cathode tube, without a grid. The tube contains a separate heating coil made of a metallic substance with a high melting-point, such as silver or tungsten. The coil brings the cathode, independently of the current flowing through it, to the high temperature required to liberate its electrons. The tube also contains the necessary cathode plate, which is one end of the conductor coming into the tube, and the anode the other end of the conductor. This tube supplies high direct voltage with low current requirements.

This particular tube supplies the high voltage necessary to filter air thoroughly. By its use, the air is ionized, or given an electrical charge. The electrically unbalanced dust adheres strongly to plates charged with opposite polarity by the tubes.

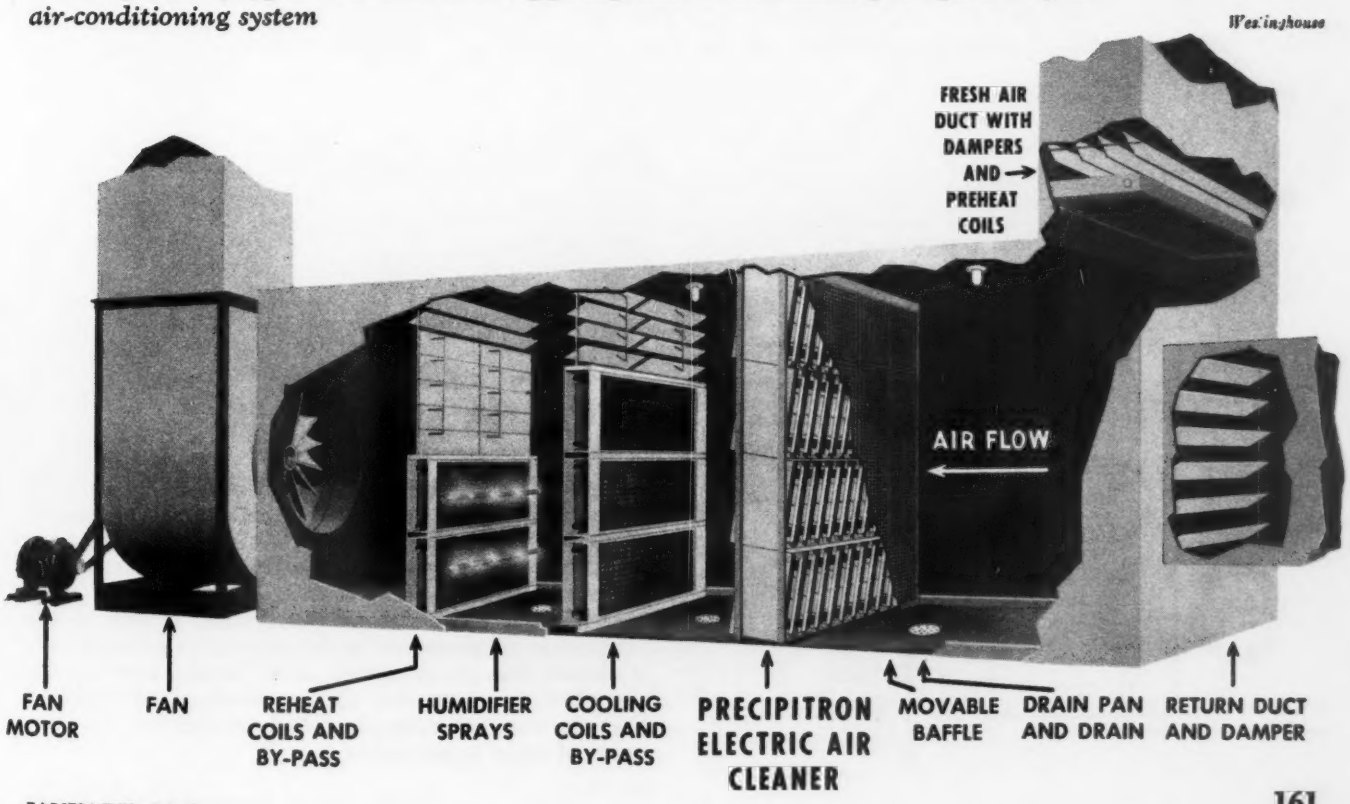
By means of the electronic precipitron, minute dust particles which defy all other air-cleaning methods can be easily segregated from the air. In fact, manufacturers claim that ninety per cent of all dust and dirt bits are taken out of the atmosphere. What is more important, however, is that its use eliminates dust and grime particles more than 1/250,000 of an inch in diameter. This fact makes the installation of electronic precipitating systems in operating rooms of hospitals feasible. Victims of allergies such as hay fever can be greatly relieved by the equipment of their living quarters with an air-filtration unit.

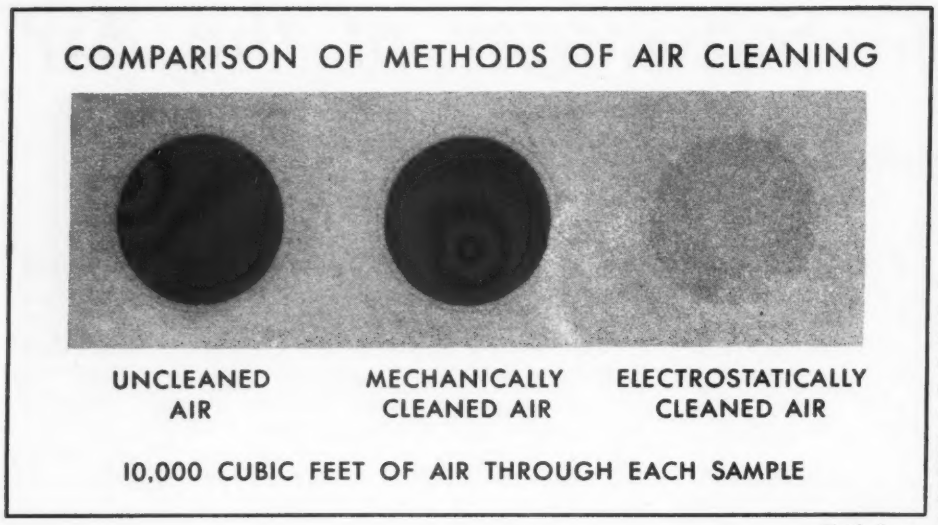
The process of air purification and cleaning has many assets, from the standpoint of health and personal comfort. One particular manufacturer is applying the tubes' abilities in a reverse fashion. Instead of cleaning the air of its myriad impurities, the precipitron is being used as the central core of the manufacturing process. This factory makes abrasives such as sandpaper. Using the tubes to create an electrostatic field, the process causes the small abrasive particles to be deposited on some adhesive paper, where they adhere properly. By this method, a fine grade of sandpaper may be obtained quite inexpensively.

In many an operation corrosive and abrasive substances, of microscopic size, damage superfinished and sensitive surfaces. Fine precision work is rejected in

Cutaway view of typical air duct showing precipitron as the cleaning component of an air-conditioning system

Westinghouse




COMPARISON OF METHODS OF AIR CLEANING
UNCLEANED AIR
MECHANICALLY CLEANED AIR
ELECTROSTATICALLY CLEANED AIR
10,000 CUBIC FEET OF AIR THROUGH EACH SAMPLE

Westinghouse

many instances because of this action. Precious time, material, and labor are wasted. The fault, invariably, lies in the fact that the conventional air filter did not capture those minute marauders of the air. By means of electronic air filtration, even the tiniest dust molecules can be removed. The production of precision products can be greatly forwarded and bettered by equipping plants with the electronic precipitron.

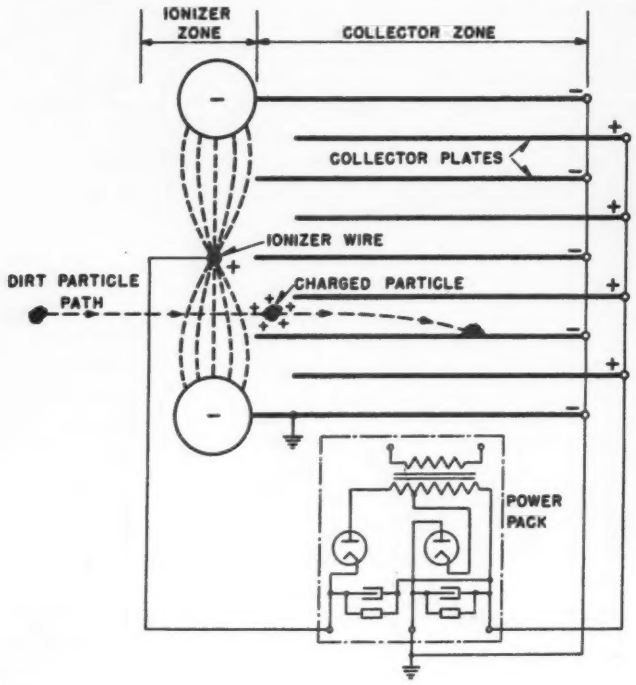
Oil mist is an obnoxious plague which besets many a production boss. Short of applying electronics there has been no real solution, but now gear-grinding and thread-cutting operations are safeguarded by the electronic air-cleaner. The tubes in the power pack create a 12,000 volt electrostatic field. Into this highly charged region the oil particles are irresistibly attracted. For more than one toolmaker, the discovery of the electron air-filter has been most welcome.

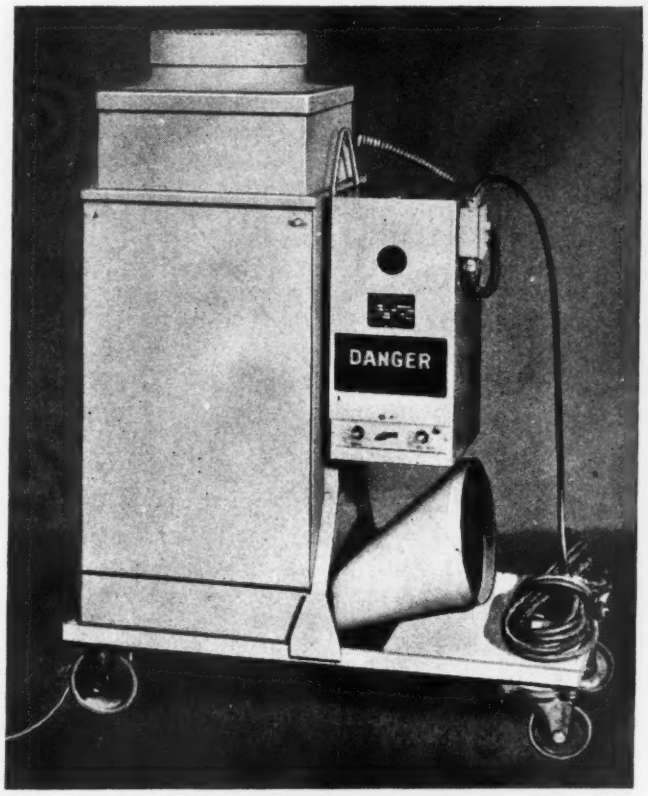
The electronic air-cleaner is employed to a large extent in the photographic industry. Film makers fear air pollution through their entire manufacturing process. Any trace of dust on a film may ruin the entire print; and many precautions must be taken against flying dust and dirt during developing, drying, processing, printing, and enlarging steps. The problem of spoilage and deterioration of optical, photographic, and close tolerance mechanical instruments is greatly lessened with the controls provided by the precipitron.

Electronic air-cleaning is only one product of a whole series of experiments by many engineers and physiologists over a period of many years. The final goal of their labors is the production within buildings of an atmosphere which would be best for human efficiency and health. It is clear that dusts, smoke, fumes, vapors, and disease-producing menaces in the air breathed by the body, determine entirely the degree of purity of the air. The real control spot is naturally inside the building: it is here that the choice of the filtering medium is crucial. The use of electronically applied precipitation gives 2.5 times the efficiency obtainable by some mechanical types of filter. For this reason, the health of the laborers and the quality of the product are both greatly improved by the installation of an electronically operated air-conditioning unit.

Sketch illustrating the principle of the precipitron

Westinghouse

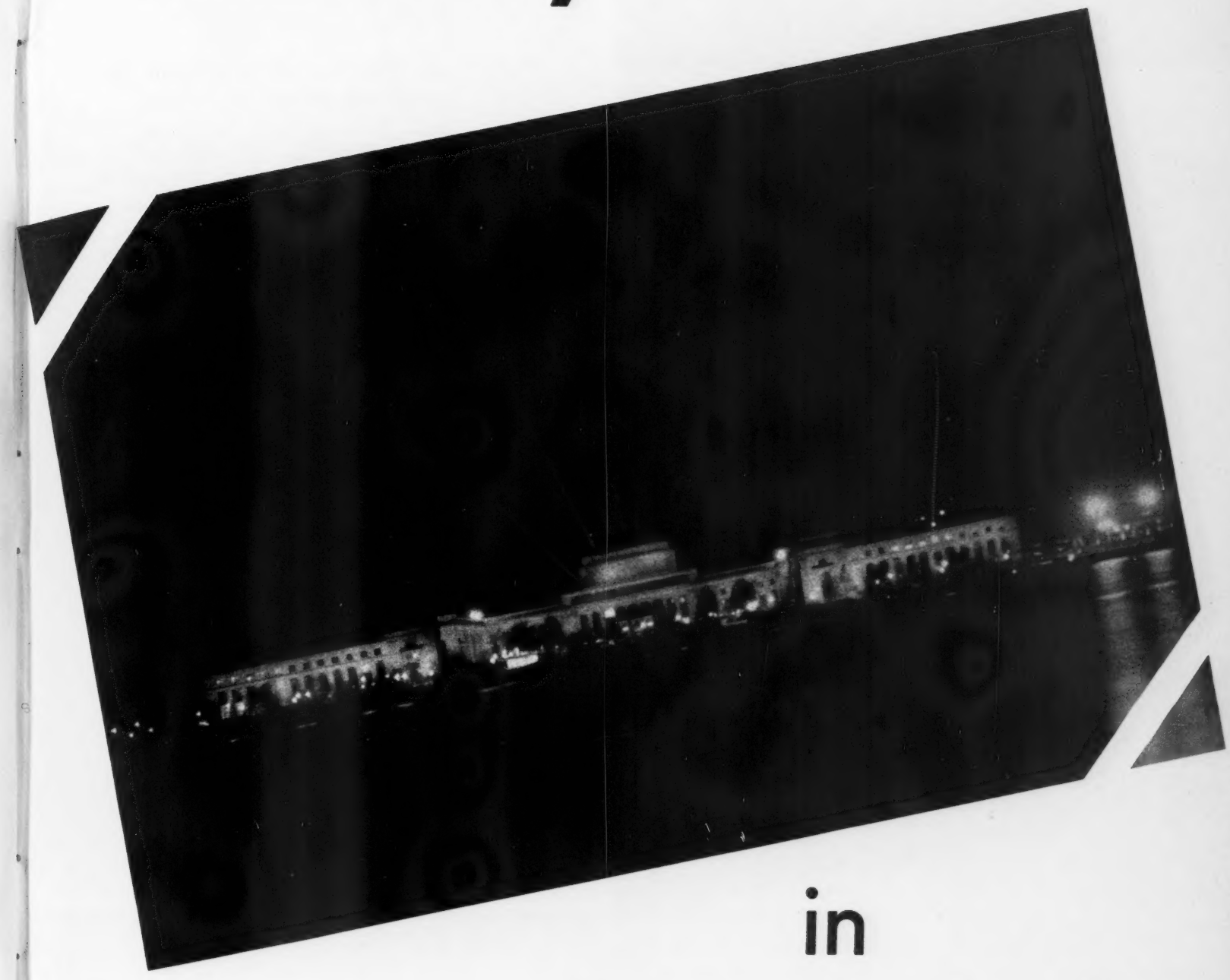




Complete mobile precipitron assembly *Westinghouse*

Although the electronic precipitron is one of the simplest of all electronic implements in its construction, it already has many varied uses. In the near future, the plant manager and the homemaker will discover that the vacuum tube-controlled precipitron has hundreds of other applications as well.

"Victory

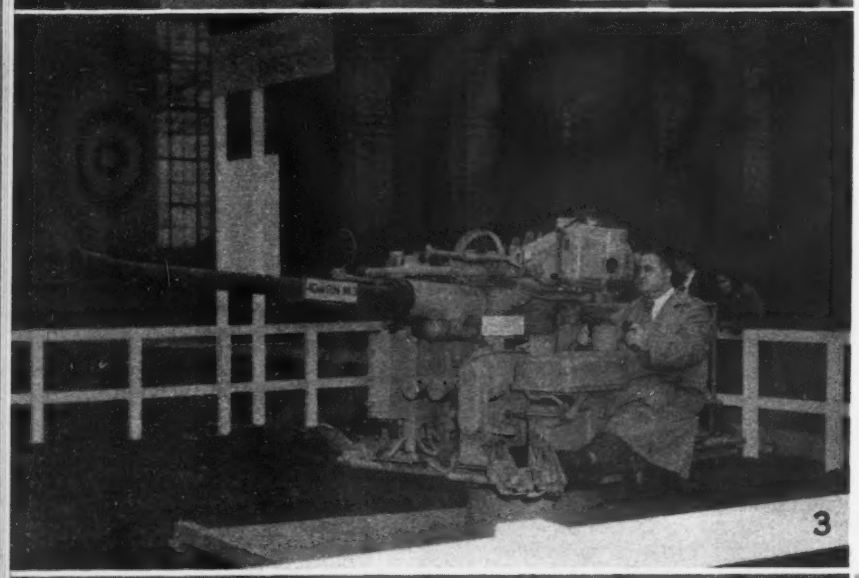


in Science"

ARMY-NAVY
AT

1 *Looking down into the Great Court.*

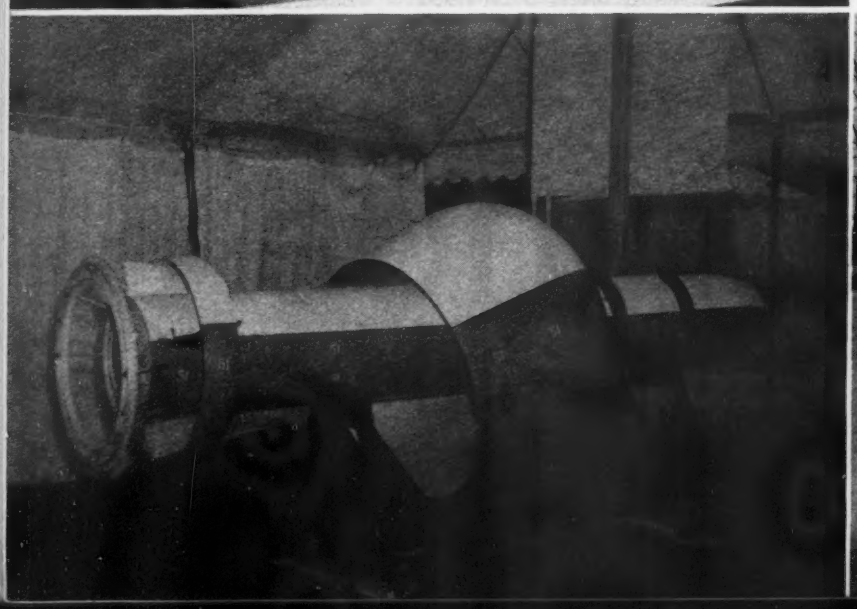
2 *Operating an automatic-loading, radar-controlled 120-mm. anti-aircraft gun.*



3 *Professor C. Stark Draper operating a 40-mm. gun with the aid of the Mark 14 computing gunsight which he designed.* (See December, 1945, Tech Engineering News.)

4 *Television-radio-controlled rocket. Circular wing containing antenna pivots to permit directional control.*

5 *Improved American version of the German buzz-bomb, built by Republic Aviation. Pylon of Building 1 in the background.*



VY BOND SHOW AT TECH

10 *Quartermaster Corps exhibit occupied entire space between Building 2 and Walker Memorial. Dorms are in left background.*

8 AND 9 *Radiation Laboratory equipment displayed in tent in M. I. T.'s Great Court. Most of the radar equipment used by the United States in the war had its origin in Tech's Radiation Laboratories.*

7 *An operating jet engine from a P-59A draws a crowd in front of Building 6.*

6 *Gas turbine engine display set up in Building 3 at entrance to steam laboratories.*

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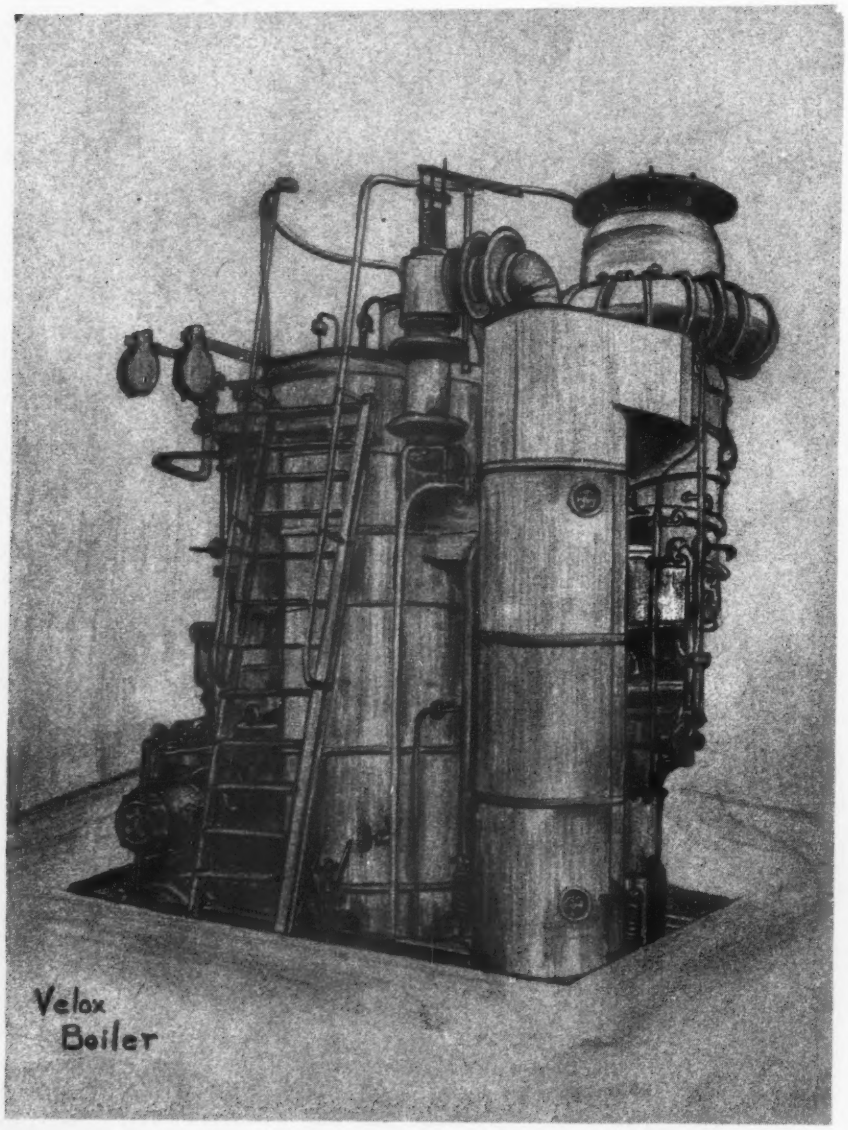
The Velox Boiler

By PAUL SANTICH, 2-47

SHORTLY after World War I the Velox Boiler was conceived in answer to the pressing need for a steam generator which would be more compact and less costly than types in use at that time. The new boiler was invented in Switzerland and was not employed to any great extent in other countries before 1930. In recent years it has been produced in increasing quantities, but because of the war and its newness it still has not found wide utilization.

The operation of the Velox boiler is made more exoteric by a discussion of two important cycles.

THE COMBUSTION CYCLE. Oil is pumped into the nozzle which is located in the combustion chamber, and, simultaneously, compressed air is blown in to ensure complete combustion. Gases which are not entirely consumed in the heating of the water drive a turbine which operates an air compressor and a generator. The latter supplies power to all boiler accessories.



Typical Velox boiler

THE WATER CYCLE. Water is pumped through tubes which are located in the combustion chamber, and from there it is driven into the steam separator. Here a centrifuge separates the steam from the water carried with it. The condensed water is fed back into the circuit with an addition to make up for losses.

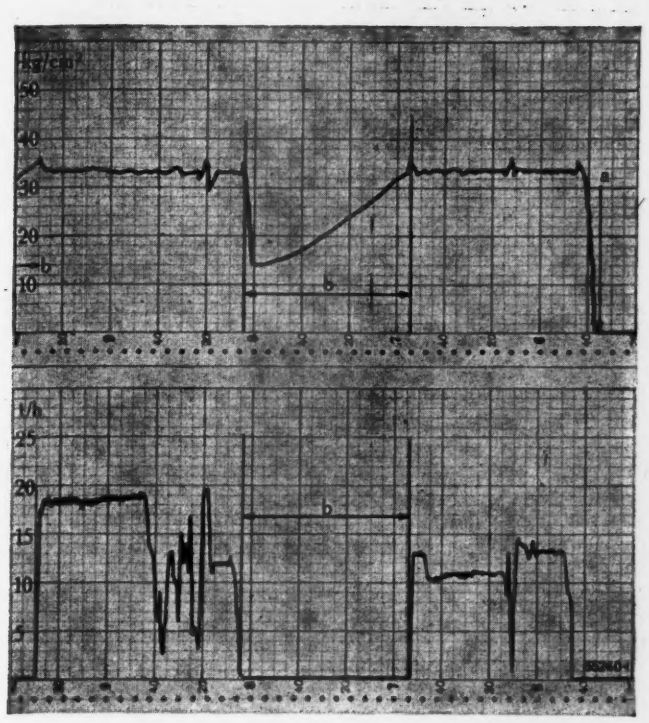
The construction of the Velox boiler is governed by the principles of heat transfer at high temperature and pressure. Elevated temperatures are obtained by means of a pressure-fire furnace; and high steam pressure and velocity result from the use of a superheater.

In the furnace heat is provided by an oil jet delivering up to six million kg.-cal. per hour. The oil pump and the high-capacity air compressor are operated by the exhaust-driven turbine. A single nozzle, set close to the furnace wall, usually does all of the heating, particularly in large installations. The super-heater is located in the combustion chamber or, in the case of a marine plant, in the flue. The pre-heater, which is also run by the exhaust gases, may change the efficiency by two or three per cent.

The water tubes are very short and usually of a quite small diameter, especially in marine boilers. High furnace temperatures necessitate the use of a water pump to provide sufficient circulation, as well as a centrifuge located in the steam-separating vessel. The latter dries the steam by separating it from the water in which it is dissolved at high boiler pressure.

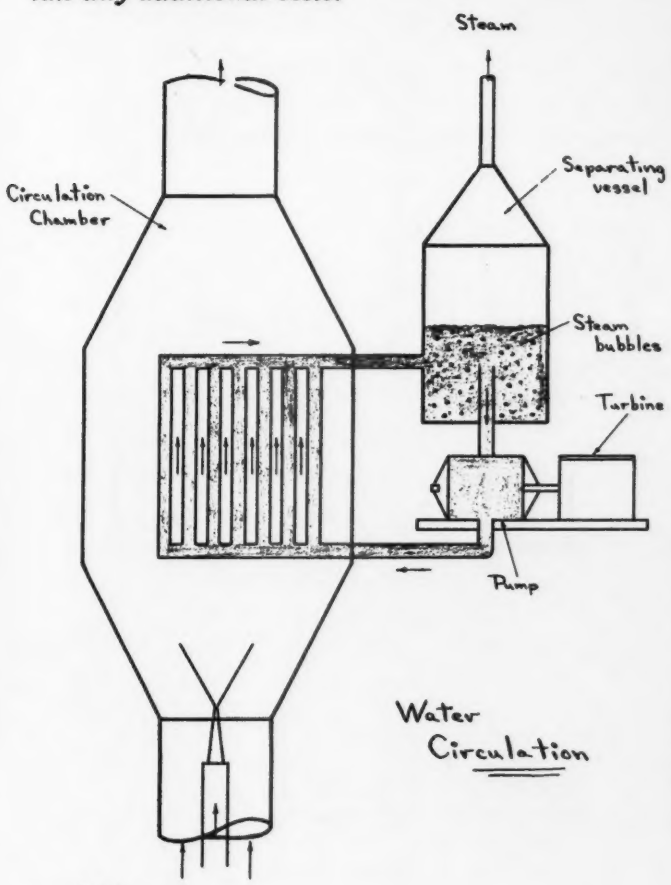
Raising steam in Velox generators can be accomplished easily and economically because of their small mass and the absence of fire brick. This is particularly advantageous in marine installations, as it is therefore unnecessary to maintain steam pressure during a stay in port. Quick heating and cooling also facilitates maintenance. Some standard types of boilers take a week to cool down; Velox plants can be completely overhauled in five days. Velox boilers are, moreover, more reliable than regular models; ten thousand hours of continuous operation is not unusual.

The Velox boiler is much smaller than the usual types, and the superheater may be placed anywhere, as long as it is in the exhaust line. When they are used in merchant ships, smaller engine rooms are needed, and thus cargo space is



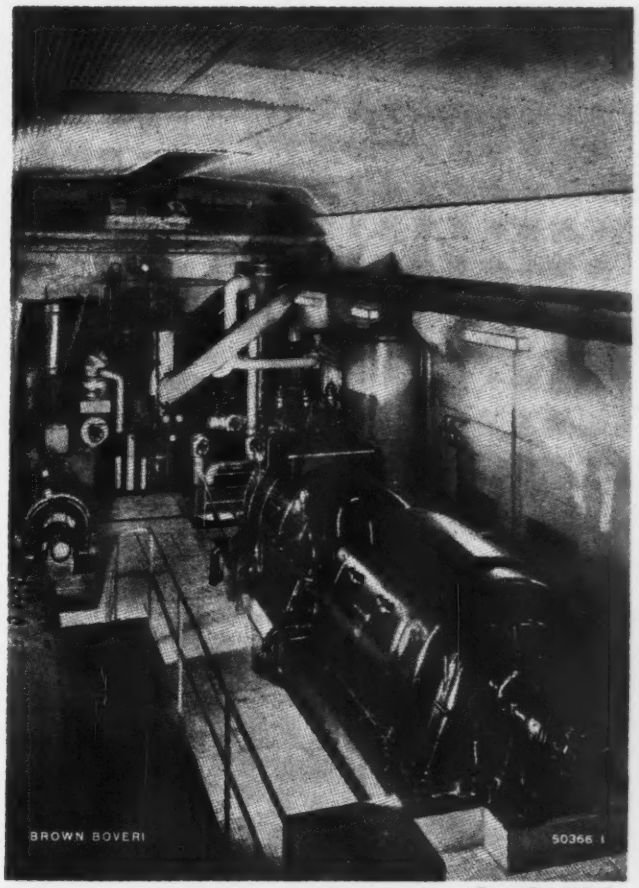
Brown Boveri Review

Typical load diagram during a test with an unexpected interruption. In spite of the unknown duration of the interruption, the boiler is shut down. Only one or two minutes are required for restarting, especially when the boiler is still under pressure. The interruption therefore does not entail any additional costs.



increased. In warships the light weight and high efficiency of these boilers make possible heavier armament and greater speed.

The Velox boiler has a thermodynamic efficiency of ninety-six per cent — six per cent more than that of any other type now in existence. It is the only boiler that can reach an operating efficiency of eighty-six per



Brown Boveri Review

Velox steam-generator in the 9,000 kw. bomb-proof power station of the city of Berne

cent in one hour. This boiler is unique in that the steam output can be closely regulated by the fuel input. The steam pressure varies little when a steady state of operation has been reached. This simplifies the operation of turbines which have to run at a constant speed. Cheaper turbine operation is made possible by the unusually high initial steam velocity.

While it might be expected that high mechanical stresses would result from the small size of the operating parts of a Velox generator, these stresses are comparable to those in conventional types, and possibly they are smaller. A Velox boiler can be operated on natural gas, oil, kerosene, or gasoline; and promising experiments are being made with a mixture of coal dust and oil.

Velox boilers have enormous possibilities now that the war is over. They have already found use in this country and are rapidly achieving recognition throughout the world. In efficiency, adaptability, and ease of control they excel all other kinds of present-day boilers.

Tech Plays House

By FRANK J. HEGER, JR., 2-47

IN recent months the housing situation here at M. I. T. has been growing worse. This condition is due mainly, of course, to the rather large influx of new students, most of whom are war veterans. Many of these veterans are married and some have children. For them the problem of housing has been very great because of the very acute shortage of suitable housing throughout this entire area. Thus, the administration decided to attempt to remedy the situation with an experiment in low-cost, prefabricated housing, hoping thereby to relieve the married veteran of one of his most pressing problems.

Accordingly, about ten acres of the Institute's vacant land along Memorial Drive (see site plan on center spread) were appropriated for the housing project which contains one hundred houses equally divided into two basic types. Each house has a plot of about 3200 square feet.

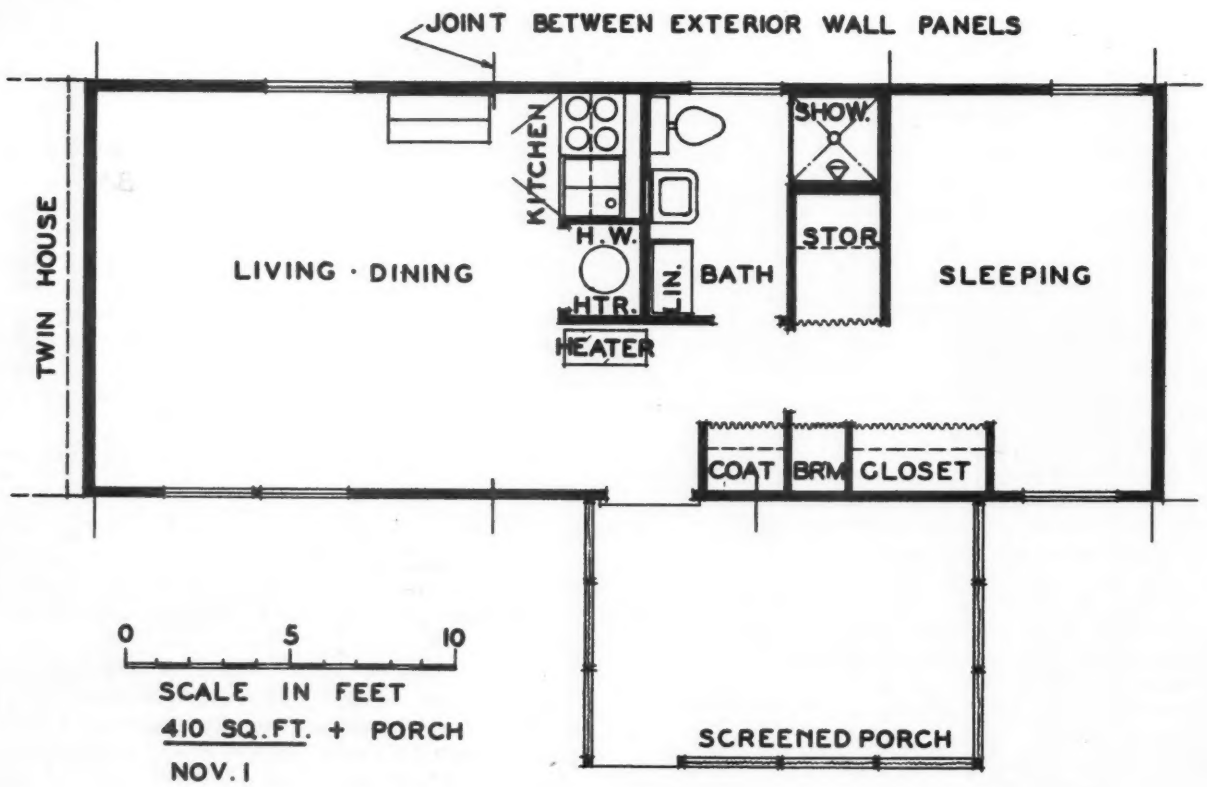
The two basic housing units mentioned above have been designated by their builders as "A" and "B." The "A" type house is designed for a married couple without children. It has a floor area of 410 square feet, actually having only two rooms. The larger of these is a combination living room, dining room, and kitchen. The kitchen is contained in one complete unit having a sink, gas range, oven, and refrigerator. The other room in these houses is a bedroom. The bathroom contains simply a wash basin, water closet, and shower.

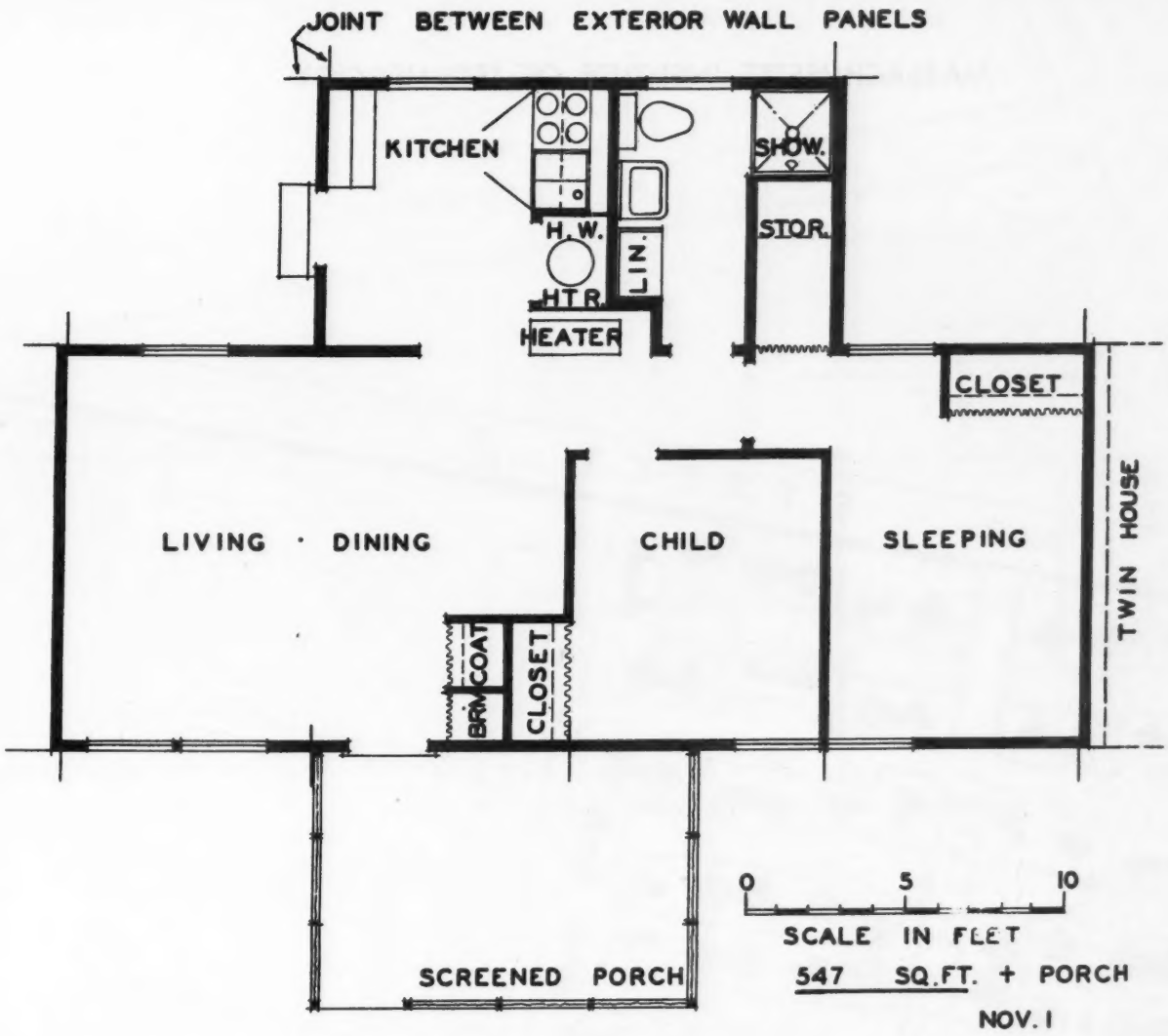
The "B" type house is considerably larger than "A," being designed to accommodate a married couple with one child. It has a floor area of 547 square feet, having a separate kitchen and an additional bedroom. The kitchen unit, however, is identical in both houses and both have a screened porch in front.

The first of the new homes goes up

It might be well to emphasize here, before going into a more detailed discussion of construction details, that these houses contain little more than the bare essentials needed to live decently. The project is of a distinctly temporary nature, having been planned for a life of

Ground plan for an "A" type house





Typical "B" type home

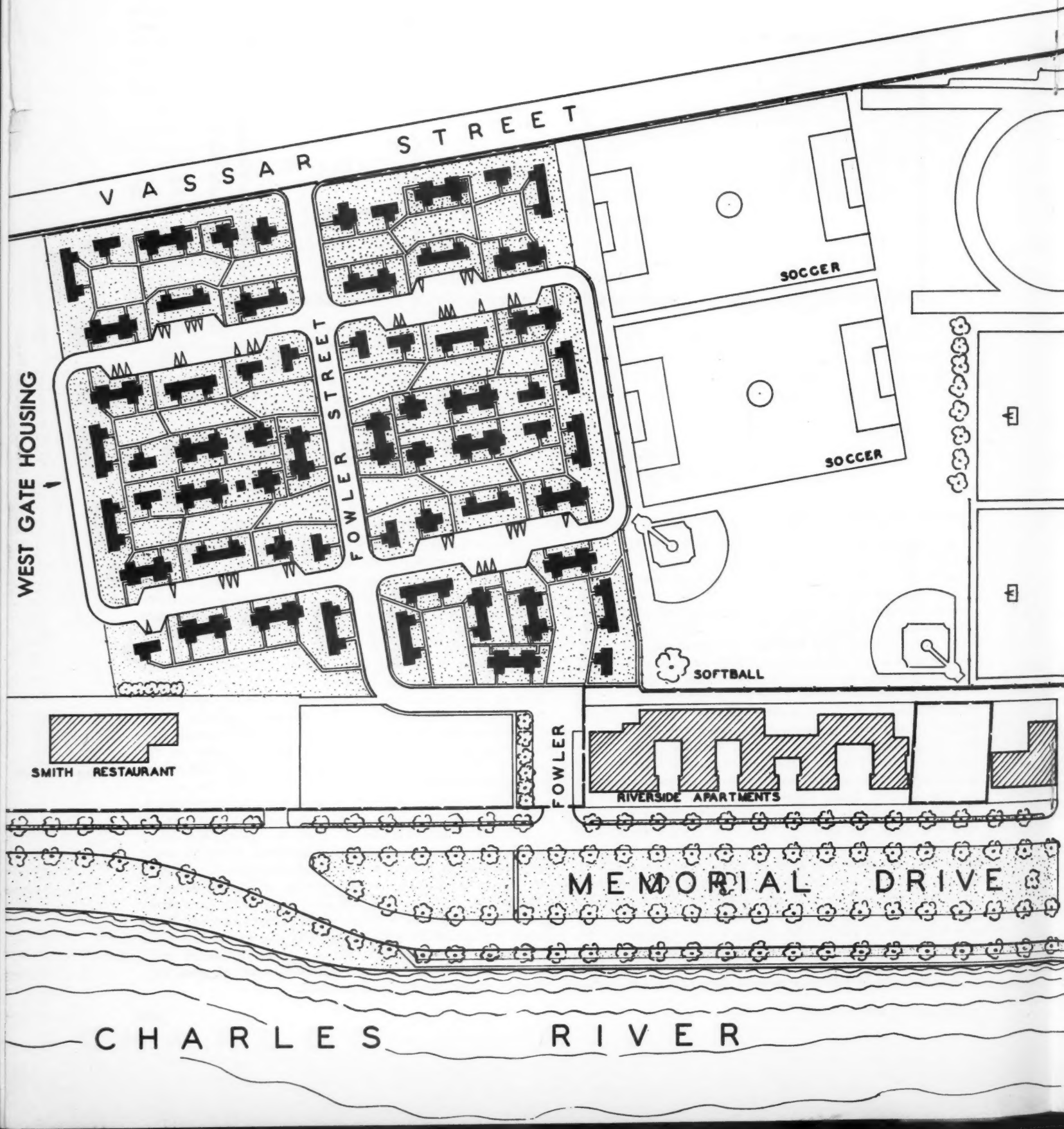
seven years at the most. Moreover, three factors have dictated the reduction of the houses to minimum size; namely, (1) original costs had to be kept low because of the temporary nature of the project and limited financial resources of most of their proposed occupants; (2) small size makes for much lower heating costs; (3) small size reduces the amount of furniture required. The reader should keep these considerations in mind when examining the construction details of these units.

Fundamentally the various units have been built up from demountable, salvageable panels, and are simply placed on cedar posts instead of having any foundation. The wall panels are from 8 to 12 feet long and 7 feet 4 inches high. They are built up from 2 x 3 inch studs with clapboards on the outside and celotex wallboard on the inside. Each panel is complete with its own insulation which is aluminum foil. The floors are constructed from oak panels. The roofs on all the houses are simple gable, built up from panels constructed with toxic-treated plywood, painted white on the outside to obtain a high reflectivity. All panels are fastened together with spikes, and the aluminum foil insulation extends through all panels including floor and roof. All windows are of the double hung type, equipped with screens for the summer and storm sashes for the winter. Because of the temporary nature of the project, the houses have been left unpainted (except for their roofs). Each unit is heated by a gas-fired space heater, thermostatically controlled. These heaters require very little space and are entirely satisfactory for heating a small area such as we have in this case. They have not, however, been used to any great extent in this region, but have been widely used on the West Coast with considerable success.

The cost of the project has been estimated at about sixty-five cents per cubic foot, which is not unreasonable in view of the fact that it was absolutely necessary to complete the work in the shortest possible time. Unfortunately, labor difficulties caused considerable delay in the construction work, but nevertheless the work progressed satisfactorily after the initial difficulties had been settled.

This project is actually a dual purpose experiment, for it will not only help relieve the housing shortage for a number of married men at Tech, but it will also allow Tech to become the "perfect" landlord, actually seeking complaints from tenants. This criticism can be used to great advantage in improving postwar housing. Moreover, these houses will give M. I. T. a start in its program of research in methods of prefabrication. Later on it is planned to build individual houses solely for the purpose of research in insulation, solar radiation, radiant heating, air conditioning, and the uses of glass, plywood, cinder blocks, and plastics.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY



MASSACHUSETTS INSTITUTE OF TECHNOLOGY
EDUCATIONAL BUILDINGS

MASSACHUSETTS AVENUE

CAMBRIDGE

BOSTON

STORES

PRINCETON AVENUE

BEXLEY HALL

TECH. STORE

ARMORY

PRESENT PARKING

BRIGGS FIELD HOUSE

PROPOSED ATHLETIC CENTER

AMHERST STREET

GRADUATE HOUSE

UNDERPASS

PARKING

PROPOSED FACULTY CLUB

DANFORTH

CAGE

RUNNING TRACK

TENNIS COURTS

TENNIS COURTS

HOSP.

LA CROSSE

LA CROSSE

ENDICOTT

The Pillory

Know all ye readers that the following persons have been convicted of being on the staff of that magazine known as The Tech Engineering News, and for that rank offense they are hereby sentenced to a one month stand in the public pillory.

Maurice Rifkin, 2-47

Into the office of T. E. N., one warm and humid evening, walked a fat man. The thing that shocked them most in that small but well filled office was that this piece of technical obesity talked as well as walked. This remarkable object was classified by the cognomen of Maurice Abdul Mahommed Washington Rifkin of a long line of Rifkins. The first recorded action of this thing upon entering the activity end of his Alma Mater was to write his name on a slip of paper. This so awed the staff that they made *it* circulation manager. Here was a man who could write the English language; he was just the man to act as liaison between this gloomy office and the outer world of seventeen and a half subscribers. After serving out his sentence of one term in the back office, and having discovered that he could obtain subscriptions by sitting on the subject instead of reasoning with him, *it* was promoted. Because of *its* valuable experience and assistance in the circulation field they made *it* Advertising Manager. *This was a big mistake.* Here the inner circle of T. E. N. had failed to recognize the fact that Moe liked money. Moe liked money so much that he actually did some work. So it was that the inches of dust that had accumulated on the floors and desks of this hallowed office were stirred for the first time in ages. (*Cont. p. 183*)

THE TECH ENGINEERING NEWS

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The Dragon's Den

An Old Friend . . .

Back in the dim and distant years when *T. E. N.* first descended upon the defenseless inmates of the Institute, there yet existed the "remembrance of things past" known as tradition. And a little piece of this tradition detached itself from its more prosaic fellows to become the Tyranian Dragon, mascot of the staff and inspiration of the Managing Board.

Despite its decided resemblance to a somewhat intoxicated frog — but then it is not every dragon that could give such a convincing imitation — the Dragon hung for years on the walls of various *T. E. N.* offices, viewed only by those fortunates who had irrevocably committed themselves to the maintenance of the standards of publication set by the original founders of the magazine.

In the course of numerous volumes, however, the original details concerning the mysterious appearance of T. Dragon lost their significance, and it came more and more to represent the guiding spirit of the organization.

For some time now the Dragon has been gone from the office, and a little of what he stood (or hung) for has been gone as well. Perhaps it was because of the war, perhaps because dragons have lost their appeal in this modern age of ours. But whatever the reason, our friend was no longer dusted off quite so often; and being temperamental, as dragons are, it finally disappeared one dark, cloudy night.

In the present staff, however, we feel that much of this lost interest has been found once more. The individuals who worked to achieve this rejuvenation deserve a lot of credit. Some of it will appear with the March promotions. And to symbolize, in a way, this recaptured spirit, we have reclaimed the editorial from its dusty corner under the masthead to place it under the watchful eye of the Dragon.

Convention Notes . . .

A few weeks ago we received in the office a rather terrible group portrait of a really swell gang of future engineers of assorted gender. The picture, taken at the last Annual Convention of the E. C. M. A. (which *T. E. N.* was instrumental in founding back in 1921), recalls cheerful memories of that week-end in Columbus last October. Our representative, as usual, looks pretty thoroughly beat, but de pite all appearances to the contrary was having one happy time.

Delegates were present from practically all of the twenty or so active member magazines, comprising an outstanding group of students from engineering colleges all over the nation. Most of the magazines were represented by their managers or editors; notable was the large proportion of women delegates. *T. E. N.* has its cherished few women staff-members, but has never had anything so exciting as a woman Editor.

The spirit and interest shown by all of the forty representatives was evidenced by an almost universal participation in the discussion following the presentation of papers on the various problems of college publications in the engineering field. Even more remarkable was the congeniality of the group as a whole; a number of informal parties brightened the small hours of the morning for many of the less-fatigued.

Particularly we would like to compliment the *Wisconsin Engineer* on its very accomplished Editor — not only has she a most fetching way of feigning interest in M. I. T., but she also dances beautifully and is a dead-shot in the Penny Arcade. Wisconsin lads, take heed!

In all respects the Convention showed a coincidence of interest among the members of the E. C. M. A. which augurs well for the future success of the organization.

S. L. S.

PRECISION CASTING

(*Continued from page 160*)

to freezing point; (2) contraction of alloy due to change of phase from liquid to solid at constant freezing temperature; and (3) contraction of solid alloy from freezing point to room temperature must also be included. Item (1) is not considered because of lack of data.

Suppose, for example, that a certain dimension is given as 1.000 inch plus or minus .003 inch. From practice it has been learned that wax shrinks 1.0 per cent; i.e., it is adopted to a warm mold and upon cooling to room temperature, it shrinks 1.0 per cent. A brass, containing essentially 65 per cent copper and 35 per cent zinc, is to be used which has a pattern-makers' shrinkage of seven thirty-seconds inch per foot, or 1.80 per cent. These shrinkages total 2.80 per cent.

Compensation calculations: The chosen investment has a setting expansion of 0.3 per cent and a thermal expansion of 1.0 per cent at 1200° F., giving a total of 1.3 per cent. There still is a difference of 1.5 per cent shrinkage. If but one casting is to be made, the pattern may be warmed by heating the investment material or letting the investment set under water to achieve a hygroscopic expansion of 1.5 per cent. Since perhaps ten thousand pieces are needed, the foundryman's method of enlargement is the best resort. However, it is necessary to produce but one master; it is well to make it accurate and smooth, as it will produce all of the patterns. A 1.5 per cent increase in pattern size is needed. Therefore 0.015 inch is added to the 1.000 inch and produces a master pattern 1.015 inches in size. This usually can be held to a tolerance of .001 inch, and often to plus or minus .0005 inch or better. These calculations are shown in the following table.

I. Heated investment or hygroscopic expansion of investment reduces wax pattern shrinkage.

	Per Cent
A. Shrinkages	
1. Wax pattern shrinkage 95° to 75° F.	0.25
2. Casting shrinkages (gold)	1.25
Total	1.50
B. Expansions	
1. Setting expansion of investment	.30
2. Thermal expansion of investment (1200° F.)	1.20
Total	1.50

Total shrinkage (1.5%) = Total expansion (1.5%)

II. Precision Casting — Foundryman's method of enlarging pattern.

A. Shrinkages	
1. Wax pattern shrinkage	1.00
2. Casting shrinkage (brass)	1.80
Total	2.80
B. Expansions	
1. Setting expansion of investment	0.30
2. Thermal expansion of investment (1200° F.)	1.00
Total	1.30

Shrinkage — Expansion 2.8% — 1.3% = 1.50%
Therefore, master patterns must be enlarged 1.5%
Total Shrinkages (2.8%) = Total Expansions (2.8%)

One advantage of the "lost wax" technique of casting is that high-alloy materials can be cast in almost any design desired. These high-alloy materials are difficult to machine, fabricate, or forge. It is difficult and undesirable to try to machine such materials because they are extremely hard on tools and require skilled workers to operate the tools; but when precision cast, these materials can be made to take the most intricate shapes without too much difficulty.

Although the need for a number of skilled operators in the precision casting process raises the labor cost above that of some other methods of manufacture, the low finishing cost offsets this relatively high labor cost.

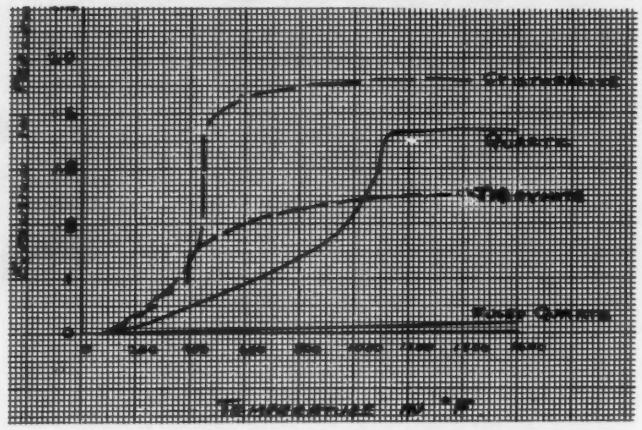


Figure 2. Thermal expansion of four forms of silica.

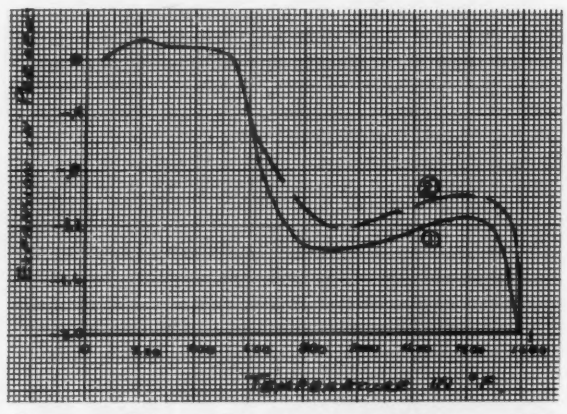


Figure 3. Thermal expansion of plaster of Paris
1 — 49 parts water to 100 parts plaster.
2 — 37 parts water to 100 parts plaster.

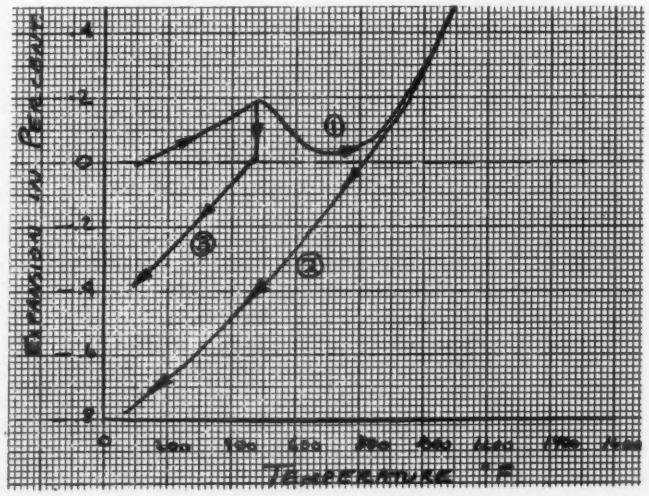


Figure 4. Thermal expansion and shrinkage curves for a typical investment

1 — Expansion on heating.

2 and 3 — Shrinkage on cooling from different temperatures.

(*Continued on page 178*)

NUMBER 1 OF A SERIES

Newsworthy Notes for Engineers

We're fussy about our Spaghetti!

In the language of vacuum tube makers, "Spaghetti" is a ceramic sleeve for insulating conductors. As the emphasis in electronics has moved toward higher and higher frequencies, tube elements have grown smaller and smaller till some "spaghetti" insulators are the size of a bristle in your tooth-brush!

The smallest ceramic sleeve now made by Western Electric measures under .030 of an inch outside diameter, with a center hole of .020 inch. This means the walls of the tube are only .005 inch thick—yet each unit is rigid, strong and provides good insulation.

In the production of hundreds of varieties of such tiny elements, Western Electric engineers have achieved remarkable precision which has had much to do with the rapid progress of electronics.

Rush! Rush!

After V-J Day, orders were to produce telephone central office equipment—*fast!* This program couldn't wait until the last radars were completed. So production engineers went into the moving business.

At one plant location they had to move everything to a new building, with 850,000 sq. ft. of floor space—virtually plan the operating layout of a new factory immediately!

Some of their problems: model floor plan; "write up" showing how many machines—what type—how many people—how many shifts—scheduling and flow of materials and finished parts—power circuits, water, lighting—conveyors and cranes—tools and benches—jigs and fixtures for assembly.

At a *single* Western Electric Works, 106 manufacturing sections required either complete or partial rearrangement and retooling. In one month, 35 of these sections were reconverted.

Tiny Crystals can't be Sissies

Delicate quartz crystals—some only one-eighth inch square—withstood a terrible beating in military radio equipment. One reason: engineers at Bell Laboratories and Western Electric devised a way to anchor them gently, yet firmly, in place—assuring stability and perfect contact between terminal wires and crystal.

Here is how it is done: after the crystal is ground nearly to prescribed frequency, a spot of liquid silver is applied at exact points for terminal wires. Baking at 1000° F fuses the silver to the crystal. Then the entire surface receives a finish of vaporized silver.

Finally—using a precision fixture—the terminal wire, with a dot of solder on its tip, is lined up with the spot of silver *and a jet of hot air anchors it firmly in place.* During the war, millions of military crystals were assembled in this manner.

Manufacturing telephone and radio apparatus for the Bell System is Western Electric's primary job. It calls for engineers of many kinds—radio, electrical, mechanical, chemical, metallurgical. Many of the things they do—whether seemingly little or big—contribute greatly to the art of manufacture of communications equipment.

Western Electric

SOURCE OF SUPPLY FOR THE BELL SYSTEM

THE FINEST STEEL TAPE

LUFKIN "ANCHOR" CHROME CLAD

The Lufkin "Anchor" Chrome Clad Steel Tape is the best for student as well as professional use. The chrome plated steel line is extra durable—stands up under rough usage. Coated with smooth, rust-resistant chrome, it will not crack, chip, or peel. Accurate, jet black markings are easy to read, they're recessed so they can't wear out. For free catalog write THE LUFKIN RULE CO., SAGINAW, MICH., New York City.

LUFKIN
FOR DURABILITY

A PLACE IN THE SUN

(Continued from page 159)

indicate low heat loss through the ceiling and roof. This combination of solar and panel heating was not a complete success. The concrete floor is slow to respond to sudden changes in demand for heat. This is because of the large mass of concrete (600 cubic feet) which must be brought up to temperature before it will supply adequate heat. The floor will also continue to give off heat after the input of hot water has ceased, and the house becomes overheated. Thus, windows must be opened, and solar heat is lost. Another difficulty was encountered in the outside heat control device which was affected by cold air currents and shadows. When inclosed in glass, the heat control device functioned more accurately.

The temperature was higher in the rooms with the largest exposed glass surfaces. This might have been caused by the concrete pavement in front of the glazed windows, which reflected light and heat into the house. Although transparent to visible light, the glass in the windows is opaque to heat radiated from the pavement. Assuming 25 per cent reflection by the pavement and allowing for some reflection from the glass, about 10 per cent of the solar energy hitting the pavement would be reflected directly into the room. Rough calculation indicates that this might be a heat gain of 6,000 Btu per hour. This is equivalent to almost 2,000 watts of electrical power.

Natural light provided sufficient illumination, even on cloudy days. When there was snow on the ground, it was necessary to put curtains over the windows to control the glare. The basic design was found to be very satisfactory.

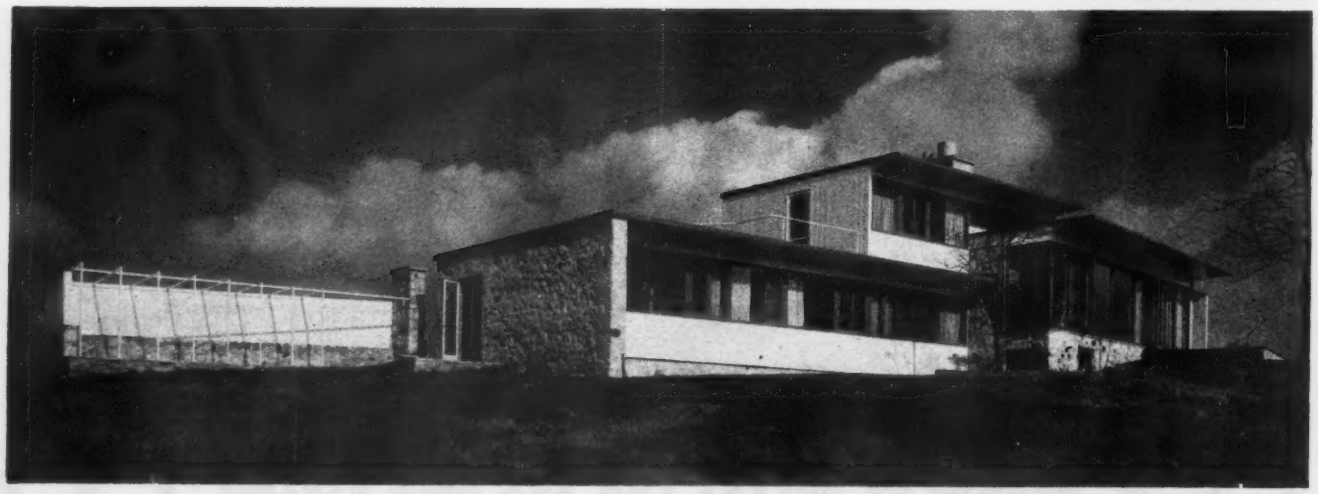
Of principal interest in this test house are the performance of the floor radiant heating system, the relationship between natural and mechanical heating methods, and the general desirability of the house design. The conclusions which may be drawn are that no definite quantitative measurements may be derived from the test, that the large windows improved the illumination but increased glare, and that the operation of the floor heating system was unsatisfactory.

More recent design has added cooling devices to solar heaters. Alwin B. Newton invented a solar heating system which may also be used for cooling. In his system water is heated in coils on the roof-top, and the hot water is stored in an insulated tank in the attic. Water from the thermal storage tank may be sent through the roof coil at night, where the heat is radiated into space. To augment the heat-storing capacity of the tank, containers of Wood's metal (M. P. 130° F.) are placed in it. Similar containers, holding substances freezing at 50° F., augment the "cold-storing" capacity. Thermostats and timing devices are employed for adaptation to the household needs.

The Pentagon building in Arlington, Virginia, is heated and cooled by the sun. The sun's rays fall on photo-electric cells in five roof-top stations. In these control stations the temperature rise is recorded; and by using electronic relays and compression tanks the cells activate fans which keep the temperature of the building at about 77° F. *(Continued on page 178)*

Front view of the entire house, showing location of dining room porch. Driveway is on the other side

Hedrick-Blessing Studio



THE HUM OF THE ARC *sounds the new note in construction*

The ear-splitting, nerve-shattering staccato sounds that formerly accompanied construction will not be the theme song of post-war building. Instead, the quietly efficient electric arc will weld together the steel skeletons of new structures. And, in so doing, it will save time, space and steel.

As a major manufacturer of welding and cutting equipment, Air Reduction has pioneered many new uses for the electric arc and the oxyacetylene flame. These versatile modern "tools", together with Airco's many other diversified products, serve the needs of the nation in many ways . . . from hardening of metals to high altitude flying . . . from carbonation of beverages to the manufacture of synthetic rubber.

The operating subsidiaries of Air Reduction Company, Inc., are:

AIR REDUCTION SALES COMPANY
MAGNOLIA AIRCO GAS PRODUCTS CO.
Industrial Gases, Welding and Cutting Equipment

NATIONAL CARBIDE CORPORATION
Calcium Carbide

PURE CARBONIC, INCORPORATED
Carbonic Gas and "Dry-Ice"

THE OHIO CHEMICAL & MFG. CO.
Medical Gases—Anesthesia Apparatus—Hospital Equipment

WILSON WELDER & METALS CO., INC.
Arc Welding Equipment

AIRCO EXPORT CORPORATION
International Sales Representatives of these Companies

AIRCO

AIR REDUCTION
60 East 42nd Street, New York 17, N.Y.

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Gyro Compass
Heating Registers
Prestone Shutters
Propeller Governors
Rounds Counters
Radio Transmitters
Radio Receivers
Superchargers
Tachometers
Tach Generators
Trim Tabs
Windshield Wipers

AUTOMOTIVE
Choke Valves
Clocks
Bus Destination Signs
Engine Governors
Headlights
Radios
Speedometers
Spotlights
Taximeters
Telescoping Antennas

MACHINES
Bottling
Can Capping
Concrete Surfacers
Concrete Vibrators
Drilling
Engraving
Flame Cutting
Floor Scraping
Food Handling
Hoisting
Knitting
Linotype
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Massage
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Printing
Shoe Making
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GENERAL
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Home Radios
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Mechanical Toys
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Outboard Motors
Radar
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INDUSTRY USES... millions of feet of S.S.WHITE FLEXIBLE SHAFTS

Yes, S.S.White flexible shafts are among the most useful of basic mechanical elements. The partial list at the left will give you a good idea of the many different products in which they play a part.

And here is the reason for this extensive use —S.S.White flexible shafts provide engineers with a simple, practical answer to two problems which come up again and again in the design of mechanical products—

(1) The problem of transmitting rotational power around turns and in paths other than straight lines.

(2) The problem of mechanical remote control.

S.S.White flexible shafts, in both the power drive and remote control types, come in a large selection of diameters and characteristics to meet a wide range of requirements. Engineers will find it helpful to be familiar with the range and scope of these "Metal Muscles" for mechanical bodies.

WRITE FOR BULLETIN 4501

It gives basic facts and technical data about flexible shafts and their application. A free copy will be mailed to you for the asking. Please mention your college and course when you write.

S.S.WHITE INDUSTRIAL DIVISION
THE S. S. WHITE DENTAL MFG. CO.
DEPT.C, 10 EAST 40th ST., NEW YORK 16, N. Y.
FLEXIBLE SHAFTS • FLEXIBLE SHAFT TOOLS • AIRCRAFT ACCESSORIES
SMALL CUTTING AND GRINDING TOOLS • SPECIAL FORMULA RUBBERS
MOLDED RESISTORS • PLASTIC SPECIALTIES • CONTRACT PLASTICS MOLDING

One of America's AAAA Industrial Enterprises

A PLACE IN THE SUN

(Continued from page 176)

Eventually our coal and oil supplies will be gone. A most promising source of energy is the sun, and it is now the job of the scientist and the engineer to capture solar energy to be used for heating and for driving machines.

PRECISION CASTING

(Continued from page 174)

The cost of materials is moderate to high compared with a similar cost in other processes, but there is very little tool and die cost, and no expensive machines other than those that most foundries have. The scrap loss is also quite low because there are no shavings or metal trimmings as in other processes.

A very important factor in the employment of precision casting is, as the name implies, the precision which is obtainable through its use. This factor is mainly responsible for its success, for it is the precision of the finished casting which eliminates the need for machining.

The production speed of the precision casting process compared with the speed of other processes is not too high. Most other processes produce at a speed well above the maximum rate for precision castings. Although this may sound like a serious handicap, too much weight should not be attached to it. Precision casting saves a great deal of time in getting into production. While the time required to get into production for other processes may vary from days to weeks, only a few hours are required to get precision casting into production.

As was mentioned before, many intricate designs are made possible by using precision casting. Such surfaces as aerodynamic contours, which are practically impossible to machine, can readily be cast in the exact shape required. If the producer wishes to change the design of the product slightly, he need not make a complete new set of molds and a new master pattern. It is only necessary either to add a little wax to the wax pattern or to cut the pattern down to the right size. This can be done easily and quickly, and thus the producer will have time to experiment with shapes until he finds the best one. The design

(Continued on page 182)

RCA's new television camera has a super-sensitive "eye" that sees even in the dimmest light—indoors or outdoors.

A television camera "with the eyes of a cat"

As a result of RCA research, television broadcasts will no longer be confined to brilliantly illuminated special studios—nor will outdoor events fade as the afternoon sun goes down.

For RCA Laboratories has perfected a new television camera tube, known as Image Orthicon. This tube, a hundred times more sensitive than other electronic "eyes," can pick up scenes lit by candlelight, or by the light of a single match!

This super-sensitive camera opens new fields for television. Operas, plays, ballets will be televised from their original performances in the darkened theater. Outdoor events will remain sharp and clear on your television set—until the very end! Television now can go places it could never go before.

From such research come the latest advances in radio, television, recording—all branches of electronics. RCA Laboratories is your assurance that when you buy any RCA product you become the owner of one of the finest instruments of its kind that science has achieved.

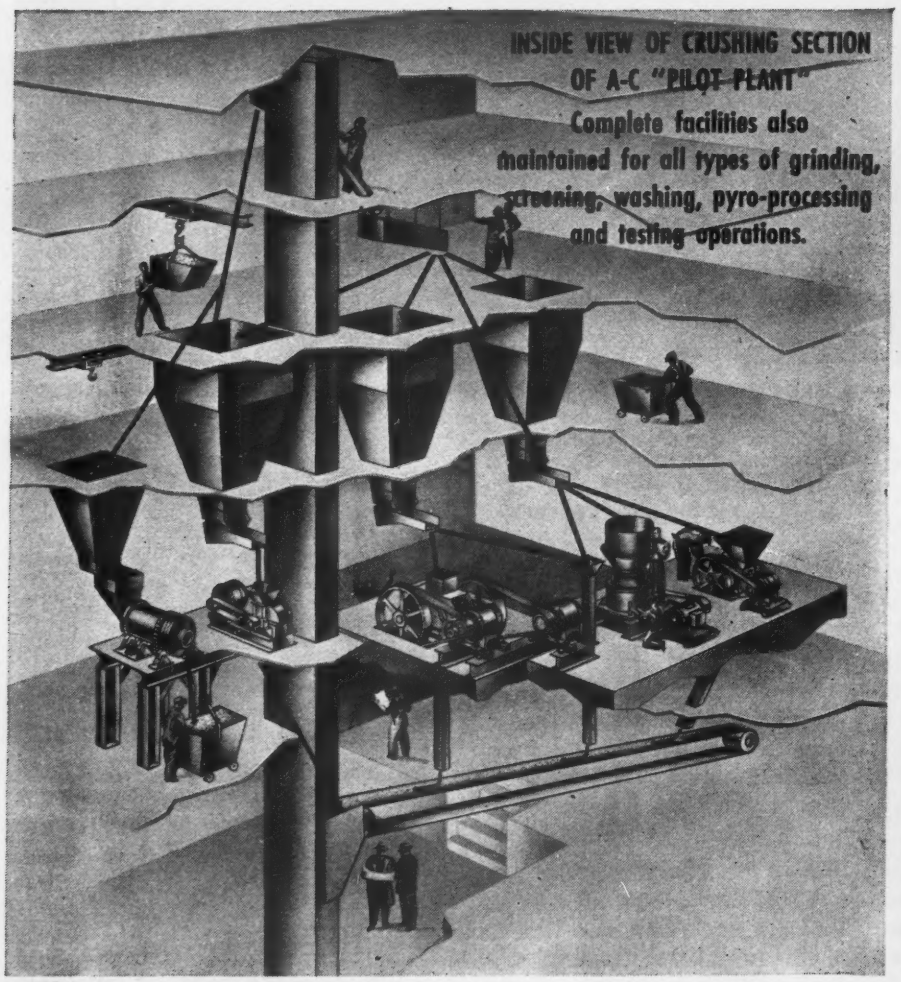
Radio Corporation of America, RCA Building, Radio City, New York 20. *Listen to The RCA Show, Sundays, 4:30 P. M., Eastern Time, over NBC.*

RCA Victor television receivers with clear, bright screens will reproduce every detail picked up by the RCA super-sensitive television camera. Lots of treats are in store for you. Even today, hundreds of people around New York enjoy regular weekly boxing bouts and other events over NBC's television station WNBT.

RCA **RADIO CORPORATION of AMERICA**

"TEST TUBE"
FOUR STORIES HIGH!

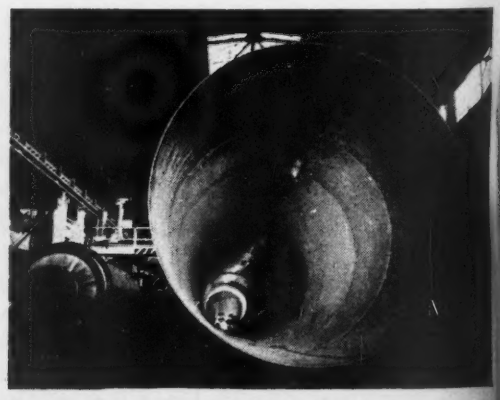
NEW BASIC INDUSTRIES LAB TYPICAL EXAMPLE OF HOW A-C COOPERATIVE ENGINEERING WORKS TO AID ALL INDUSTRY!



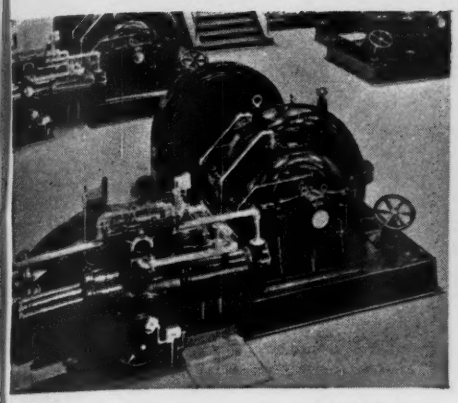
INSIDE VIEW OF CRUSHING SECTION OF A-C "PILOT PLANT"
Complete facilities also maintained for all types of grinding, screening, washing, pyro-processing and testing operations.

1 "How can we make more accurate equipment recommendations to meet specific process problems?" was the question A-C asked its own engineers. Their answer: build a laboratory so complete in every detail that it can simulate actual mill conditions no matter what the locality or basic material involved. Today, that laboratory is ready for use at A-C (crushing section above)—*one of the most extensive ever built to serve the basic industries!*

2 Inside this "pilot plant," sample ores, non-metallic minerals and synthetics can be "batch-tested" by the pound or bulk-processed in ton or carload lots. Processors and their engineers can select the right equipment to suit specific needs!

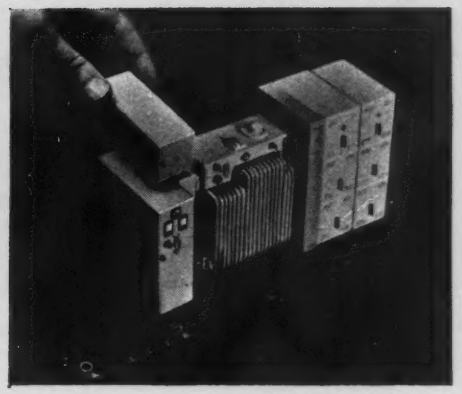


3 From the smallest vibrating screen to the largest kiln (above), Allis-Chalmers builds the most complete line of processing and milling equipment in the world! We're ready to help you with your technical problems.

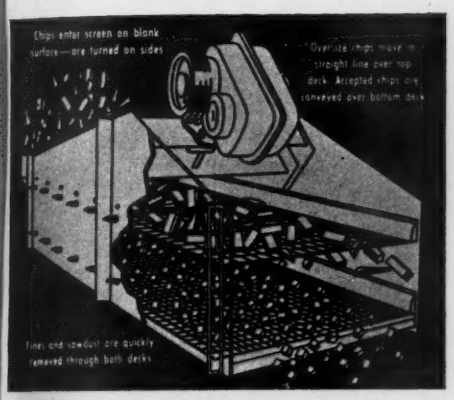


4 Look, for instance, what A-C engineering has done in water distribution. Today, one A-C Centrifugal Pump does the job of 3 old-type pumping engines 10 times its size—*does it better . . . more economically!*

5 In fact, an A-C Centrifugal Pump can deliver 75 million gallons of water a day—enough to meet the average needs of a city of 500,000. Cost to consumer? . . . as low as one cent for every 100 gallons delivered!



6 To facilitate modernization of unit substations, A-C introduced this innovation: visual planning with accurate scale models of equipment that reduce paper work—save hours of complicated figuring!


Chips enter screen on blank surface—are turned on sides
Oversize chips move in straight line over top deck. Accepted chips are conveyed over bottom deck
Fines and sawdust are quickly removed through both decks

7 For the pulp and paper industry, still other outstanding developments: the Low-Head Chip Screen (above), a new Streambarker for barking logs, a wide variety of grinders, digesters, thickeners, blow tanks.

8 Today, A-C engineered products are helping boost production of vital U. S. paper and cardboard—represent just one section of the world's largest line of major industrial equipment!

9 War-proved products and techniques — practical experience with technical problems . . . that's what this Company can offer you. For complete details inquire at your nearby Allis-Chalmers office!

Allis-Chalmers Manufacturing Company, Milwaukee 1, Wisconsin

KEEP ABREAST OF COMPETITION!

Investigate A-C's Cooperative Engineering Service. Put the World's Widest Range of Industrial Skill and Experience to work on your Production and Technical Problems.

ALLIS-CHALMERS

PRODUCER OF THE WORLD'S LARGEST LINE OF MAJOR INDUSTRIAL EQUIPMENT

A-C

Tune in the BOSTON SYMPHONY Every Saturday, over the American Broadcasting Company Coast-to-Coast, 9:30 P.M., E.S.T.

PRECISION CASTING

(*Continued from page 178*)

can also be altered by adding a complete new wax form to the original pattern.

These wax patterns are usually made in several parts which are fastened together to make the final pattern. This simplifies the casting of pieces with internal projections. The piece of wax on the pattern which is to correspond to the internal projection is fastened to the rest of the wax making up the pattern. The whole pattern is covered with investment and the wax is melted out according to the process stated before. A cavity corresponding to the internal projection is left, and when the mold is filled with metal, the projection results. Because the mold is broken off by steam, water, or brush after pouring, removing the casting having the internal projection presents no difficulty.

High surface detail may be obtained through the use of precision casting along with smooth and clean surfaces.

When the number of pieces to be made is small, precision casting fits perfectly as there is no high pattern or tooling cost. This may also include an extension of the use of precision casting for a starting point for machinery wherein a sand casting is too rough or inaccurate to permit proper checking.

Special markings, numbers, graduations, or blind holes may lead to the use of precision casting. Unsightly parting lines and undesirable drafts may be done away with, also.

Future work: Some of the paramount desires of the precision casters, and ones on which various research departments are working, are:

A. Materials
1. Harder low-fusing die metals.
2. Waxes with less shrinkages.
3. More refractory and less costly investments.

B. Equipment
1. Automatic pattern-making machines.
2. Larger casting equipment.

As the improvements in materials and enlargement of equipment are made, it will be possible for investments to replace permanent molds, sand, and sand cores in more and more types of casting work.

Precision casting is not a process that just any foundry can adopt at present. It requires equipment, apparatus, and materials that present users have developed and built for their own use, and materials especially formulated for their processes. It is believed that as these means are perfected to a point where consistent results will be possible without constant scientific supervision, the process can be made more generally available. At present no two investments on casting machines are alike; once the merits of each are more widely known, one may look for rapid improvement and growth of precision casting practice.

5,000 Refrigerated Food Lockers

This COMMUNITY REFRIGERATION CENTER Serves Over 15,000 Customers

10,000 Furs in Storage

Pat Denham's model plant, covering an entire block at Oklahoma City, provides ten distinct services: it has the world's largest food-locker system, safekeeps 10,000 furs, operates a general freezer storage, makes crystal-clear ice, processes all kinds of foods, does quick-freezing, sells frozen foods, runs a restaurant, has a gas station, and includes a big laundry. Frick refrigerating, ice-making, and air conditioning equipment carries all the cooling loads.

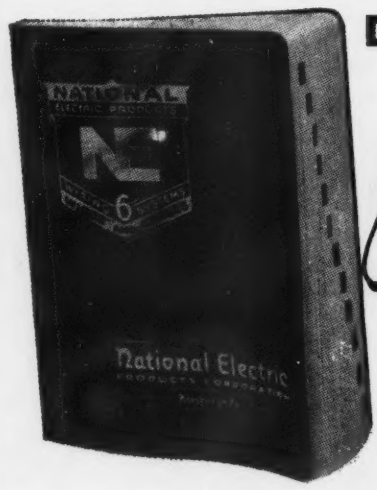
14-Ton Ice-Making System

Bulletin 126 tells how any town o city can profit from a similar COMMUNITY REFRIGERATION CENTER. Write for your copy now.

Air Conditioned Sales Room

FRICK CO.

Our 350 Page Electrical Engineering Data Book



FREE!

This most comprehensive book on wires, cables, bus systems, conduits and surface raceways and their fittings is yours for the writing. Informative and instructive, you will find it very helpful in your work.

National Electric
PRODUCTS CORPORATION
Pittsburgh, Pa.

The Pillory

(*Continued from page 172*)

Few people know this happy fat man the way we do, and we feel that a general description would be of value to the young man interested in getting ahead in the journalistic world. Here we have a human being that is so big that his interests are limited to things that are behind double doors or greater. This restricted him to only the highest class of publications. Below the border, *it* is so broad that *it* can settle comfortably only in the widest of padded swivel chairs. Thus it was that our fair-haired boy was destined for either a manager's position or a job with the Department of Sanitation. The former being, by a small margin, the lesser of the two evils, our boy progresses. Classification carrying us thus far by a purely physical analysis, a mental examination leads us to the following interesting conclusions. Of the few class A publications on our broad and tree-shaded campus, *its* huge I. Q. of "Moron third grade" immediately made *it* eligible for the technical journal, our beloved *T. E. N.* Because *it* was limited in counting over twenty, and the staff was confident that this limitation would not be taxed by the total subscription list, it was only natural to find *it* in the circulation department. This thing was ambitious, and by working night and day *it* learned how to count above twenty. When this horrible example was discovered by the other members of the staff, this example of an intellect in a moronic atmosphere, *it* was immediately removed from *its* position of responsibility. When it was discovered that *it* could not be pried, forced, shoved, or crowbarred out of the door due to a newly discovered expanse of epidermis, it became the sad task of the staff to find some new position for this body they called a man.

This unexpected situation caused the staff to reach a new high of efficient placement. It was discovered that here was a man that was capable of lifting a quarter-page advertising plate without the use of block and tackle. *It* was made Advertising Manager. It is confidentially reported from New York that after the advertising agency had its first contact with this master of the advertising profession, publications that used this agency were forced to change publication dates, due to the shattered nerves of the agency men.

So it was, as day faded into night, and day faded into night, that *T. E. N.* came and *T. E. N.* went and the fat one could still not be pushed through the door; and *it* remained. *It* had one remarkable characteristic that could not be ignored: *It* ate; by God, how *it* ate. *It* ate, eats, and will eat, anyone, anything or anybody out and under any handy table or tables as the case may be. While the Techmen work and other men sleep, this one eats. *It* eats in class, *it* eats to and from class and in between. *It* carries a shoe horn for getting in and out of class, and by constant practice has done rather well. *It* has a heart of gold. *It* will pat you on the back, lend you ten dollars, twist your arm or kick you in the face as its pleasant moods find *it*.

In all seriousness, Moe Rifkin is a good guy. There is no one that does not like him. He has that good-natured, easy-going way that is conducive to making friends. His friends are varied, to say the least. He mixes well with everyone, and girls think that he is cute (to show how little the female sex knows); and we, the guys who know him, like him a hell of a lot. Little more can be said about Moe, who might leave us next term for the service, except that he is a right guy.

(*Continued on page 184*)

A major oil company is reinforcing its technical and supervisory staff in foreign operations.

Applications are desired from:

ENGINEERS . . . Chemical, petroleum, electrical, mechanical, civil, structural.

GEOLOGISTS . . . Structural, surface, subsurface.

GEOPHYSICISTS . . . Computers, party chiefs, interpreters.

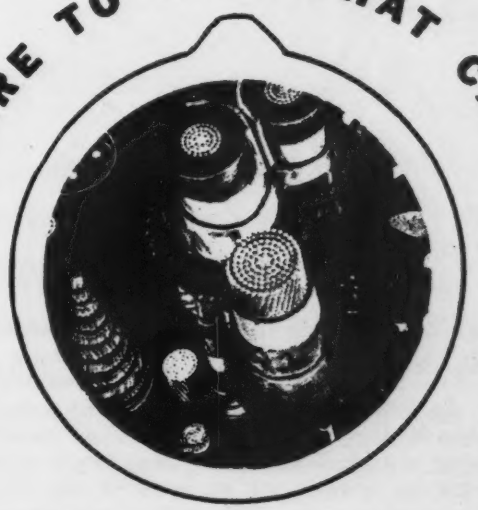
PALEONTOLOGISTS . . . Micro and macro.

ACCOUNTANTS . . . Must have degree in accountancy and supervisory experience.

• Liberal salaries are paid. Overseas employees are eligible for the company retirement plan, group life insurance and group aviation insurance. Excellent living conditions prevail. Passport and travel expenses are paid by the company.

Write to Box No. 3 , including full information on the following: Personal Data (age, family status, etc.) Education . . . Details of experience . . . All letters are held as confidential.

•WHERE TO USE WHAT CABLE•



Okonite's general catalog on wires and cables contains information on conductors and coverings, materials and fabrications, and a selector chart. Engineering students may obtain a free copy of this booklet by writing for Bulletin OK-1011. The Okonite Company, Passaic, New Jersey.

OKONITE
INSULATED WIRES AND CABLES

The Pillory

(*Continued from page 183*)

Henry L. Lee, 2-47

Henry Lawrence the third (no less) has been in our midst down here in T. E. N.'s office for well over four terms now. A happy and innocent country boy, he arrived from the thriving metropolis of Dallas, Pennsylvania, flushed with the glory of his fifty-six merit badges obtained from an industrious career of systematic gold-bricking in the Boy Scouts.

Since his arrival in this land of horrid weather and equally horrid physics exams, Henry has been specializing in the Square-Dance option of Course XX (sometimes described to elderly gray-haired relatives as "Applied Biology"). It has been bruited about — and somewhat truthfully at that — that Henry is strongly attracted to women art students of the blonde or carrot-topped variety. The consequent drop in this year's enrollment in the Boston art academies, and the corresponding popularity of the darker shades of brunette hair-rinse have come as a profound shock to usually imperturbable authorities.

Having consistently led his class through the tortuous maze of high school studies presented under the guise of a college preparatory course, Henry resolved to let someone else do all the work once he had reached the monastic shelter of Tech's acid-stained walls. In the keeping of this resolution he has been preëminently successful, and he is notorious about the campus for obtaining his grades entirely by the methods of intuitive reasoning he absorbs from a constant perusal of the latest works of *Astounding Science Fiction*.

During his idle moments at the Institute, Henry sometimes attends a class or two in Chemical Engineering, a practice in which he has indulged so frequently indeed as to lead some of his professors to suspect that perhaps he is not a casual visitor after all. But this is not allowed to happen often, however, as Henry is really quite conscientious about ignoring the more wearisome details of Tech life. In fact, his only troubles at M. I. T. are his weekly quantitative analysis quizes, where his ouija board and divining rod are often fouled with ice and after industrious manipulation invariably give the wrong answers in the addition of atomic weights.

The career of H. Lee as a hopeful protégé of T. E. N. has been one constant, bitter struggle against promotion. Despite his efforts, however, he has risen steadily through the masses of staff-members cowering behind the wastebaskets and hatracks in pitiful attempts to avoid the notice of the Make-Up Editor.

Feeling that he is doing quite enough extraneous work already and that it is interfering with his social life, Henry's greatest ambition is to stay off the Managing Board. To this end, he devotes his spare time to spreading disparaging remarks about the Editor-in-Chief. In fact, he has become such a recognized authority in this form of after-dinner amusement that even the General Manager seeks his advice in questions where choice of the appropriate epithet is doubtful.

Yes, Henry will go far in his quest for knowledge; some say he has gone far enough already, but then she is not speaking to him any more so it does not matter so much after all. We would like to wish him luck in his future investigations — and may he convince them all as he did us.

IN THE FEBRUARY ISSUE OF

T. E. N.

THIS IS M. I. T. — Geology

Supersonics

Dielectric Heating

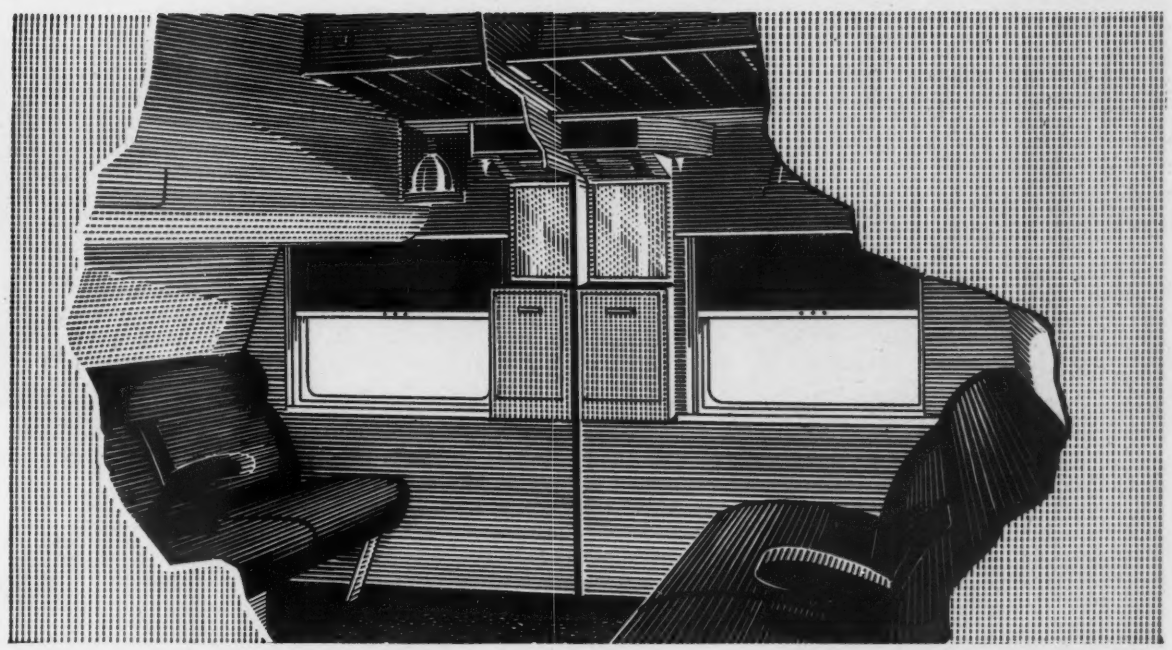
M. I. T. Sugar Research

and others

DON'T MISS IT!

A SLEEPING CAR

WITH *32* INDIVIDUAL ROOMS



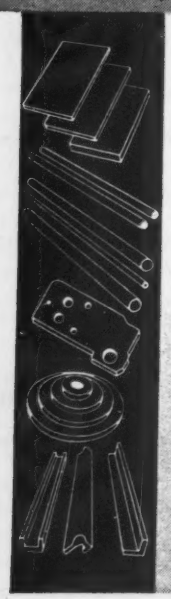
That's the Budgette—one of the new and modern sleeping car accommodations designed by Budd. It presents an opportunity for the railroads to offer at low cost the comfort and privacy always before associated with more expensive rooms.

Each Budgette has its own full-size bed, pre-made and easily drawn into position—each has its own private toilet and lavatory. The window is wide and unobstructed, the upholstered seat roomy and comfortable. Budgettes are arranged in pairs so that by folding a partition, two rooms may be thrown into one—if desired.

Other new Budd-designed accommodations for day and night use include the Cabin, the Double Bedroom and the Master Room. All continue the Budd policy of providing the finest possible equipment for railroads and the traveling public.

EDWARD G. BUDD MANUFACTURING COMPANY Budd

Roentgen Gave Us "Armor-piercing" Eyes



SHEETS

RODS

TUBES

FABRICATED PARTS

MOLDED MACERATED and MOLDED LAMINATED FORMS and PRODUCTS

X-RAYS had been produced for over a hundred years before Roentgen discovered their nature and possibilities.

He unlocked a mystery. Within a few days from the announcement of his discovery, practical uses for X-Rays popped up all over the world.

That's the way it often is with plastics. Plastics are here but all their applications are not apparent. To make them "click" for you it may only be necessary for you to tell us what you need in a material. If it's excellent insulating characteristics, resistance to corrosion, stability over a wide temperature range or a combination of many other properties, our type of technical plastics—Synthane—may do. Let's help you find out. Send for our catalog of Synthane Technical Plastics. Synthane Corporation, Oaks, Pennsylvania.

SHEETS • RODS • TUBES • FABRICATED PARTS
MOLDED-LAMINATED • MOLDED-MACERATED

SYNTHANE

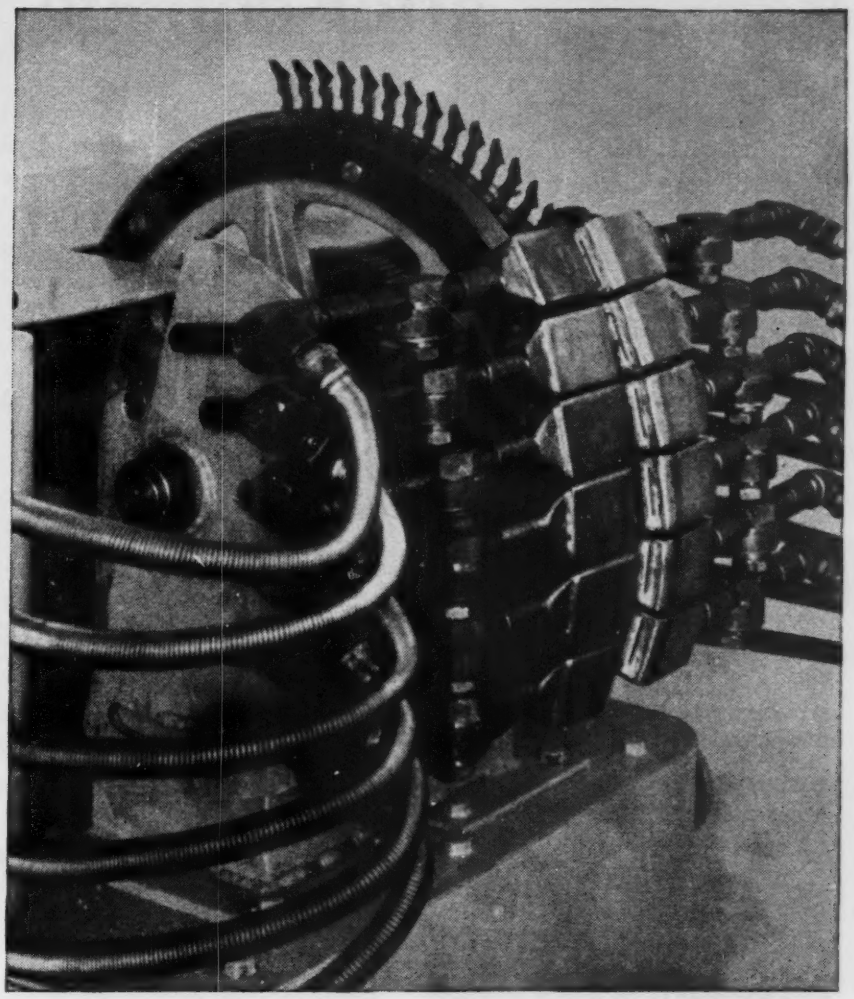
Plan your present and future products with Synthane Technical Plastics

GAS, OUR MOST *versatile* FUEL, *helped saw our way to Victory*

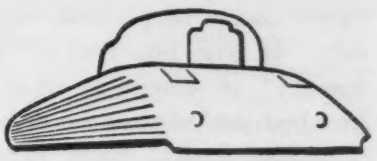
Our troops, moving through tropical forests, found it often necessary to cut down trees of the tough teak family—to make passage or perhaps to use this sturdy timber for their needs. To saw down these trees required a cutting edge that could indeed, not only "take it" but "deal it out."

Sawteeth or bits are removable; they must be extremely hard at the edge, soft and ductile where they are attached to the band of the saw. This calls for specially well controlled heat treating of the part. Gas and modern Gas heat treating equipment solve the problem.

On a circular track they run the gauntlet of 12 slot-type, ceramic cell burners, emerging with exactly the qualities demanded by their stern use. This furnace, operated by a girl, can heat treat 2,000 saw bits per hour, is adaptable to the heat treatment of many other small parts, bringing to bear an intensity of focused heat just where it is needed.



Conversely, in a mid-west plant, Gas furnaces did a most successful job of heat treating large hull castings of tanks, 22 feet long and 10 feet wide. That's a far cry from saw bits but Gas takes both extremes in its stride. The Industrial Engineer of the local Gas Company will check over any heat treating problem—and help put this versatile, modern fuel to work solving it.



AMERICAN GAS ASSOCIATION

420 Lexington Avenue, New York 17, N. Y.

THE TREND IS TO GAS

FOR ALL INDUSTRIAL HEATING

Straight talk about your after-college job

No. 1. An engineer should find out what he can do best

AS A COMPANY made up largely of engineers, we have observed a good many young engineers on their first job.

One thing we have discovered is that each student engineer will have a special ability in some phase of his chosen profession. When given a chance to apply that special ability in the right place, an industrious man usually makes a good beginning.

More often than not however, the student engineer is not sure where his special ability lies. Neither can his first employer be sure. Temperament and personality, we find, have as much bearing as university training on what line of work an engineer should follow.

It quite often happens therefore, that while doing productive work, a man will expose latent talents which he, himself, did not know he possessed.

■ That is why we think it is wise for a young graduate engineer to go with a company which will undertake to give him a varied course in practical experience. It gives him time to "find himself;" to determine what he likes best, and what he can do best.

At The Timken Roller Bearing Company, student engineers are given an opportunity to work in various departments of our business. While doing productive work, they are watched carefully for the development of special aptitudes. And in the meantime, they get a broad and solid grounding in our policies, products and manufacturing procedures.

■ Our course is particularly valuable and interesting to trainees because the operation of our business requires widely varied engineering skills. We manufacture tapered roller bearings for every industry. And we operate a large alloy steel mill which produces high quality alloy steels in a wide variety of standard and special analyses.

If you will soon be awarded a degree in Metallurgy or in Mechanical, Mining, Chemical, or Electrical Engineering, and you would like to know more about our plan, drop us a line now. The Timken Roller Bearing Company, Canton 6, Ohio.

The Timken "Work-as-You-Learn" Plan of Training

FOR BEARING DIVISION

1. Bearing Manufacture
2. Tapered Roller Bearing Design
3. Industrial Application Engineering
4. Automotive Application Engineering
5. Railway Application Engineering
6. Alloy Steel Production and Sales
7. Purchasing Department
8. Field Engineering Service
9. Sales Order Department
10. Sales Engineering in Field

FOR STEEL AND TUBE DIVISION

1. Electric and Open Hearth Melting Shop
2. Steel Rolling Mills
3. Heat Treating (Canton Plant)
4. Bar Finishing and Inspection
5. Tube Finishing, Heat Treating and Inspection
6. Stainless Steel Forge Shop
7. Tool Steel Mill and Forge Shop
8. Production Scheduling Department
9. Metallurgical Laboratory
10. Metallurgical Service (Customer Contacts)

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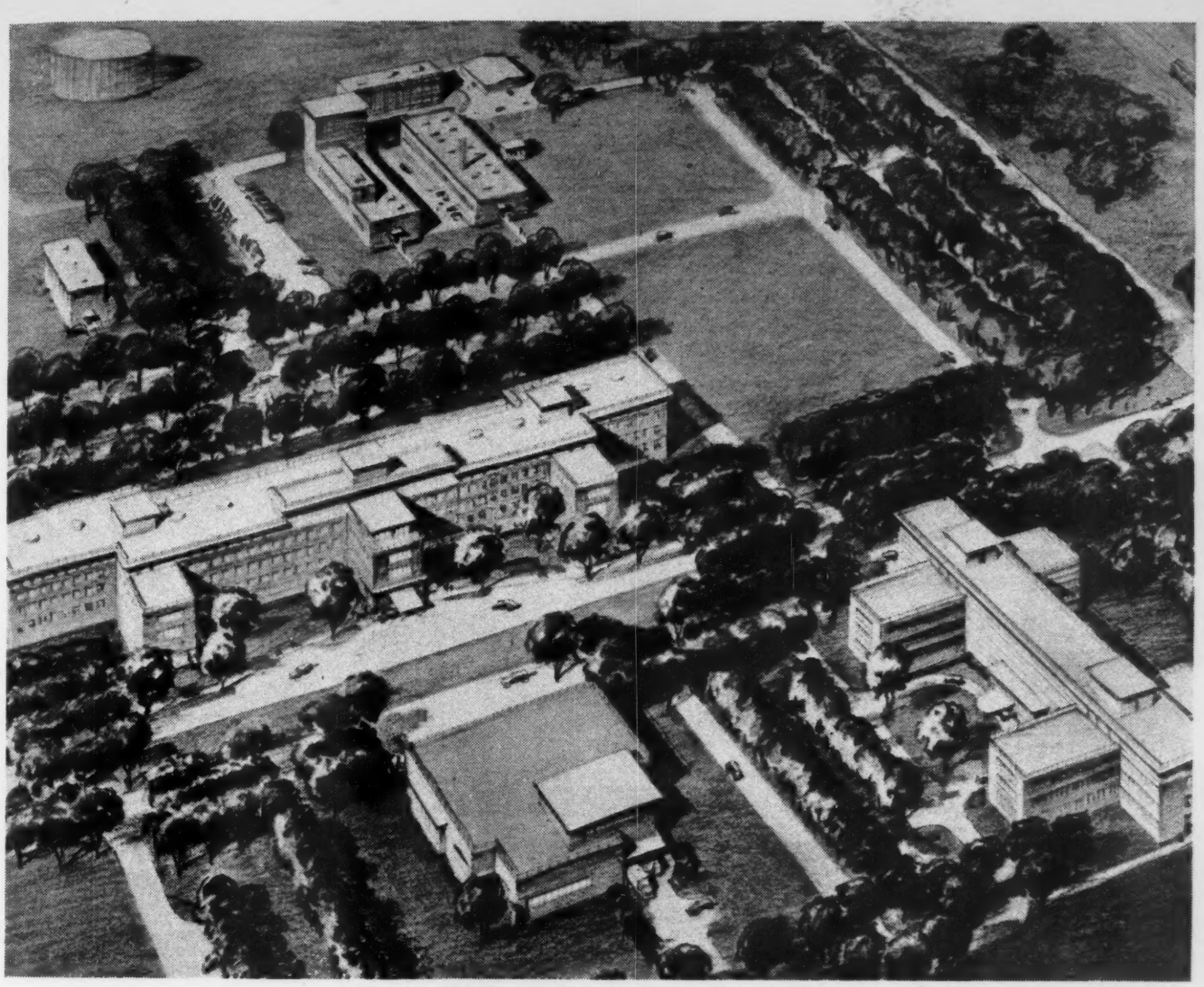
THE TIMKEN ROLLER BEARING COMPANY

PRODUCTS: World's largest manufacturer of *tapered roller bearings*. Specialists and large producers of *fine alloy steels* for industry. Manufacturers of *removable rock bits*. **U.S. PLANTS:** (All in Ohio) Canton, Columbus, Mount Vernon, Wooster and Newton Falls. **FOREIGN ASSOCIATE PLANTS:** British Timken, Ltd., Birmingham, Wolverhampton, Northampton, England; S. A. Francaise Timken, Asnieres (Seine) France. **SALES OFFICES:** In principal cities.



Architects' drawing of the proposed 8 new Esso Research buildings at Linden Park, N. J.

What is the future of Research Work?

"BIG AND IMPORTANT"—is the answer of the world's largest petroleum company, which expects to spend as much as $8,000,000 in building two giant new Esso research centers to be located at Linden, New Jersey and Baton Rouge, Louisiana.

This new program will still further enlarge Esso Research Laboratories—already the most modern and extensive petroleum research facilities in the entire United States. And as part of this expanded research program the staff of Esso scientists and research workers – at present 2100 – will be upped at least 20 per cent.

What sort of work will they be doing?

Basically these new Esso research centers will be devoted to maintaining American leadership in the production of fine fuels, lubricants and chemical products derived from petroleum. Specific research will include work on the production of liquid hydrocarbons from natural gas, the gasification of coal, and the production of oil from coal and other carbonaceous deposits such as oil shale. Studies will also be conducted on extremely low temperature polymerization, important in the field of new plastics, the further development of Butyl, one of the numerous synthetics originally developed by Esso Laboratories, and hundreds of associated subjects.

Esso

UNENDING RESEARCH WORK ASSURES THE HIGH QUALITY OF ALL ESSO PRODUCTS

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CAMPUS NEWS

RESEARCH AND ENGINEERING KEEP GENERAL ELECTRIC YEARS AHEAD

CHEMISTRY AT GENERAL ELECTRIC

GIVE a young chemist access to a well-stocked laboratory and modern equipment, and the example of such General Electric scientists as Dr. Irving Langmuir, Dr. W. D. Coolidge, and Dr. W. R. Whitney, and two things are likely to happen. First, he will find satisfaction in his work, and second he will come up with something new and useful.

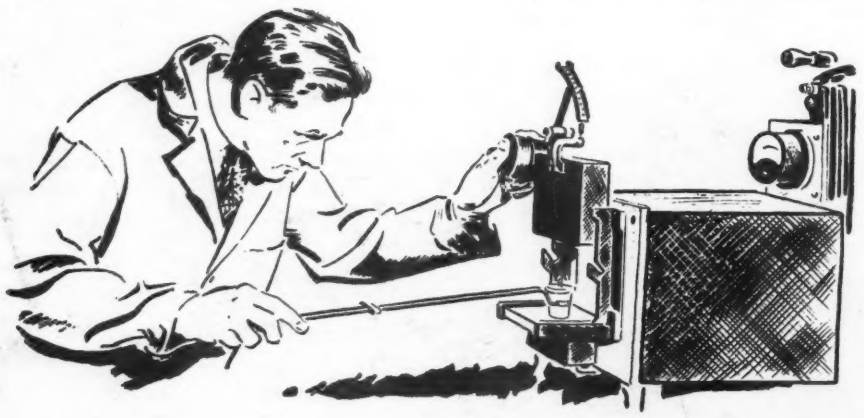
In the G-E Research Laboratory have been born the ideas that have developed into many improved chemical products. And in the Pittsfield and Schenectady laboratories of the newly established Chemical Department, groups of young chemists are conducting research and development in some of the most promising fields of chemistry.

Opportunities in chemistry

From finding insulation for electrical products to becoming the world's largest manufacturer of finished plastics products is a long step forward in the chemical field. G.E.'s expansion into chemistry—brought about by the discovery of new compounds—was inevitable. The new field of silicones alone presents infinite possibilities of research and development. It already yields oils, greases, insulation, resins, rubber, and water repellents—all with unusual new properties.

Any phase of chemistry—research, development, design, engineering—is open to the G-E chemist. A chemist interested in development carries the ideas of research through to practical products. He may develop plastic foam, find new uses for an old product, study the reactions of a by-product of some chemical process, and have the satisfaction of seeing his idea through to the pilot plant stage.

The chemical engineer works with the equipment that processes the chemicals. His job is to design and control the equipment in a chemical plant or pilot plant. In this work he must be able to understand all factors affecting the production of a commodity and to direct and co-operate with the men who are doing the actual work in the plant.



G. E. looks ahead

At present G.E. is planning the construction of five new Chemical Department plants, including one for the manufacture of silicones. And the rate and character of the growth of this new industry depend to a great degree upon the ability and enthusiasm of the young men who will fill the positions made available by peacetime expansion.

General Electric, Schenectady, N.Y.

GENERAL ELECTRIC

THE MURRAY PRINTING COMPANY
CAMBRIDGE MASSACHUSETTS